



HOLIDAY TECH PROJECTS

BUILD A PC FOR OCULUS RIFT • CREATE THE ULTIMATE NETWORK STORAGE BOX • MASTER THE AMAZING RASPBERRY PI + MORE!

PRAGMATIC HOW-TOs

- Install the Windows 10 Preview
- Turn a Raspberry Pi into a media PC
- Speak to your Mac
- Learn to code Java

LATEST REVIEWS

- Intel's affordable six-core CPU
- HP's tiny microserver
- Mammoth AOC ultrawide monitor
- Nvidia Shield Tablet

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All the major AMD & Nvidia GPUs compared! Find the right one for your budget!



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13

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FIPP

Get your tech fix

The holidays are the best time of year to
break out the screwdrivers and roll up your
sleeves, says APC's editor.

For most APC readers, the
end-of-year holidays is a
time when we catch up with
family and friends, eat lots,
get some sunshine and – hopefully
– weasel a bit of free time from all
that to get stuck into some gritty
tech projects.

With that in mind, this month,
we've set about digging up some of
the most-fun holiday projects we
could think of around PCs and tech.
We've started off with the
Raspberry Pi, putting together an
in-depth primer that'll give you a
heap of know-how about using this
extremely versatile little single-
board PC. We figured the best way to
learn about Pi was to put together a
bunch of mini-projects, so that you
can get creating things with it
immediately – there's no better
encouragement than seeing results,
after all! We've explored a few of
these concepts in more depth in our
regular Raspberry Pi masterclass,
but there's a heap of new skills to
learn and, importantly, neat new
things to build and code yourself.

Darren Yates has taken a crack at
building a \$50 PC this month,
powered by one of the plethora of
'Android on a stick' devices that you
can find online. While Android is
obviously optimised for
touchscreen devices, it does have
native keyboard and mouse support
built-in, so it's perhaps not as
outlandish as you might think!

Of course, the holidays is also just
about the perfect time for
upgrading your PC – or building a
whole new one, whether you want to
do so on a budget as we covered in
our October issue (shameless plug:
you can get digital back issues on
Google Play and the Apple
Newsstand) or throw together a
high-performance PC for video or
rendering work (in which case,
you'll want to check out the Core
i7-5820K we've reviewed on page 16)
or build a ballsy gaming rig around
one of Intel's new 900-series GPUs.
The end of the year is (it's hard to
forget) the peak gaming season
when all the big, demanding
releases land, and it's certain that
more than one APC staffer will be
setting aside some of their holiday
time to get to know these.

But no matter what you get up to
over the break, we hope you get
your tech fix! And if you make
anything nifty, give us a yell and
tell us about it!

Have a great holiday season –
we'll see you again early next year!



DAN GARDINER
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Contents

Issue 410 Christmas 2014



HOLIDAY TECH PROJECTS

BUILD A PC FOR OCULUS RIFT * CREATE THE ULTIMATE NETWORK STORAGE BOX * MASTER THE AMAZING RASPBERRY PI + MORE!

ADFGX
A q w g l m
D r t b h p
F c i f v s
G e a n x u
X y d k o j

94

CRYPTOGRAPHY OLD & NEW

JOIN JONNI BIDWELL ON A JOURNEY
OF CODE MAKING AND BREAKING,
MYSTERY AND INTRIGUE...

» features

64 HOLIDAY TECH PROJECTS

64 Master the Raspberry Pi
72 Build the ultimate DIY NAS
78 Build a PC for Oculus Rift
84 Build a media PC with your Pi

88 ESCAPING THE FUTURE

Technology and psychology are combining to increase immersion like never before. How are they doing it, and is it always a good thing?

94 CRYPTOGRAPHY: OLD & NEW

Join Jonni Bidwell on a journey of code making and breaking, mystery and intrigue...

» technotes

6 NEWS

The latest developments in the tech world.

10 GADGETS

Hot tech gear we want to own.

12 EPINIONS

See what APC's readers are talking about.

14 END USER

Not everything is plain sailing in the tech world.

"Are the simulations we currently call games the perfect escapist tools, or do they add to the problem?" Escaping the Future, p88

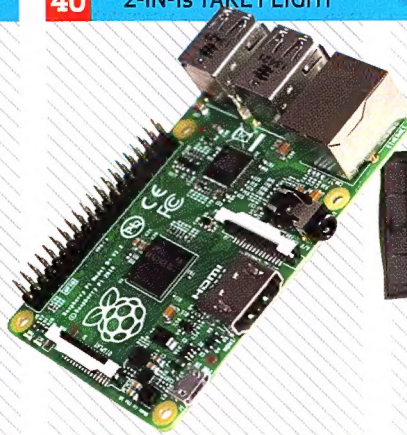


21 MSI X99S SLI PLUS

40 2-IN-1s TAKE FLIGHT



31 SONY XPERIA Z3 COMPACT



17 RASPBERRY PI B+



26 THECUS N4560

» the lab

16 LATEST REVIEWS

- 16 Intel Core i7-5820K
- 17 Raspberry Pi B+
- 18 HP ProLiant MicroServer Gen8
- 20 Sapphire Radeon R9 290X 8GB
- 21 MSI X99S SLI Plus
- 22 AOC U3477PQU
- 24 Apple iPad Air 2
- 25 Nvidia Shield Tablet
- 26 Thecus N4560
- 27 Drobo mini
- 28 Canon Pixma MG5660
- 28 Fractal Design Define R5
- 30 Razer BlackWidow Chroma
- 30 Logitech G402 Hyperion Fury
- 31 Nvidia 3DPlay TV
- 31 Sony Xperia Z3 Compact

34 SOFTWARE REVIEWS

- 34 Windows software
- 35 Apple Mac software
- 36 iOS App Store
- 37 Google Play (Android)
- 38 Windows Phone 8 apps

» how to

98 QUICK TIPS

We fix readers' computing problems.

100 TUTORIALS

- 100 Install the Windows 10 Preview
- 102 Tell Yosemite what to do
- 104 Teach Siri about family relationships
- 106 Create hyperlinks using macros

108 MASTERCLASSES

- 108 Arduino: Basics #3 – Lighting LEDs
- 110 Android: Build a dual-core PC for under \$50
- 114 Coding: Part 3 – If this, then that; otherwise something else

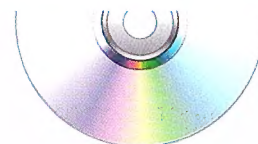
» downtime

118 GAMES

High-performance playtime.

122 CHIP CHAT

News from the world of geekdom.



» on the disc

- » Ashampoo Internet Accelerator 3
- » Abelssoft StartupStar 2014
- » Incomedia WebSite X5 Home 11
- » 1-abc.net Settings Organizer 7
- » Cave Story: full game
- » Graphic Design Essentials Toolkit

Find your disc inside on page 83.

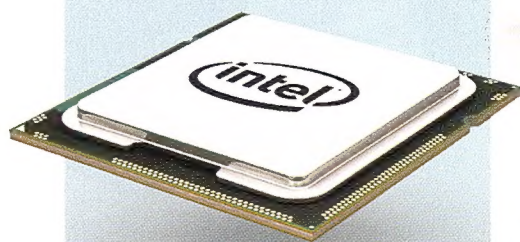
technotes

» NEED TO KNOW

Carved in stone

Worried that all of your important files on your hard drive, DVDs or flash drives could be in danger of getting lost?

The M-Disc might be the answer. While it looks like a regular DVD — and can be read in any DVD drive — it has a 'rock' layer that engraves your data 'in stone'. While ordinary removable media lasts around five to eight years, the M-Disc apparently will keep your data safe for up to 1,000 years! M-Discs also now come as Blu-rays with 25GB of storage. A pack of 15 Blu-ray M-Discs costs US\$67.50 on the M-Disc web site (www.mdisc.com) — although you might be able to source cheaper prices if you dig around local Australian e-tailers. Not too bad a price if they work as well as promised.



Intel posts 'best ever' profits

Go back a couple of years and you could criticise Intel for being slow to respond to the mobile shift in the marketplace.

But don't fret about any long-term repercussions. For the first time ever, Intel has shipped more than 100 million microprocessors in a single quarter. Those sales led to Intel posting a record US\$14.6 billion in revenue for the third quarter, along with operating income of US\$4.5 billion, and net income of US\$3.3 billion.

"We are pleased by the progress the company is making," said Intel CEO Brian Krzanich. "We achieved our best-ever revenue and strong profits in the third quarter. There is more to do, but our results give us confidence that we're successfully executing our strategy of extending our products across a broad range of exciting new markets."



Tablet sales are tanking

Are consumers falling in love with PCs again?

People are fickle creatures. For proof, turn your attention to the technology sector.

Remember when notebooks were red hot? They've since disappeared (though arguably returned in spirit in the form of Chromebooks), and now tablets are the hot item. At least, they were. According to Gartner, the tablet market is showing signs of saturation, and consumers are falling in love with traditional PCs all over again.

"Consumers' attention is slowly going back to PC purchases as tablet adoption peaked with mainstream consumers," said Mikako Kitagawa, principal analyst at Gartner. "The transition from PCs to tablets has faded as tablet penetration has reached the 40-50% range."

Gartner's PC shipment numbers are roughly in line with what fellow analyst IDC has also noted. According

to Gartner, global PC shipments hit 79.4 million units in the third quarter of 2014. That's actually a 0.5% drop from the same period a year ago, but the firm saw positive results in Western Europe and North America, which it sees as a sign of recovery.

Gartner has Lenovo as the top supplier, with 19.8% of the market. HP is second with a 17.9% share, then Dell (12.8%), Acer (8.6%), and ASUS (7.3%).

Unlike IDC, Gartner didn't have Apple overtaking ASUS for fifth. "For the first time, the top five's share reached two-thirds of worldwide shipments. All five showed stronger growth compared to the industry average," Gartner said.

With Windows 10 due in mid-2015, bringing the promise of greater integration between PCs and mobile devices, the most versatile and resilient platform of all looks set for yet another resurgence.

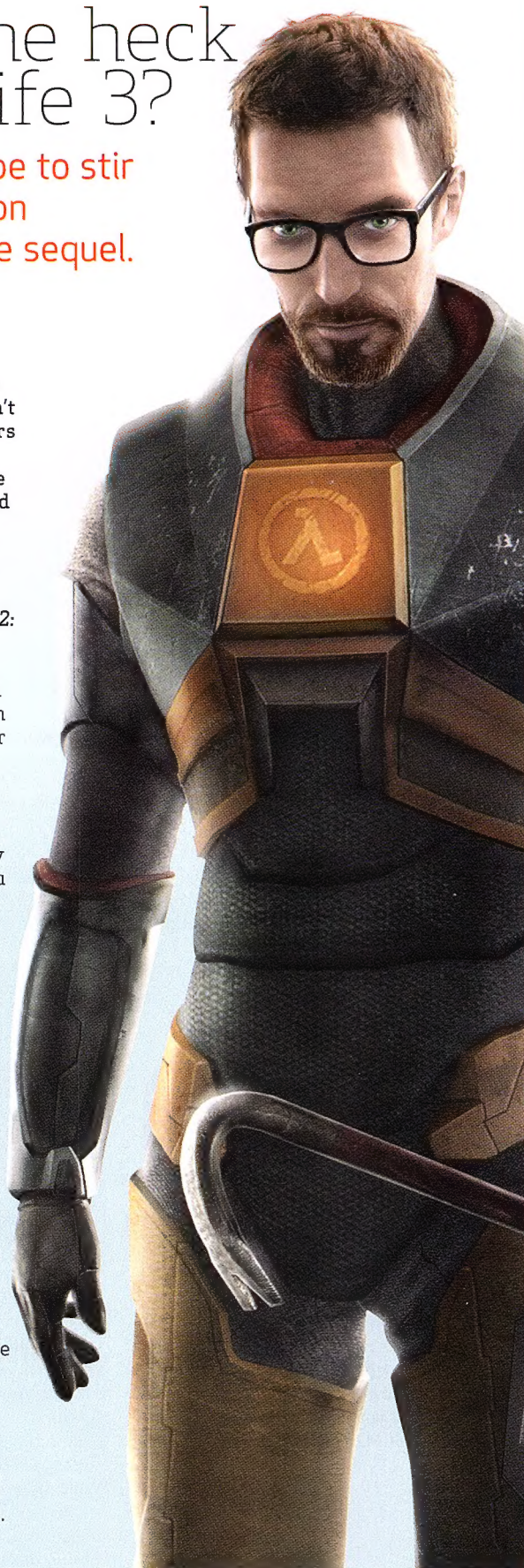
Where the heck is Half-Life 3?

Crowdfunders hope to stir Valve into action on long-awaited game sequel.

So, regrettably, it turns out *Half-Life 3* still isn't a thing. Yes, after years of hopes, dreams and enough whining to tear a hole in reality itself, the continued adventures of Gordon Freeman still elude us, a full decade after *HL2* and seven years after the latest bite-sized mini episode, *Half-Life 2: Episode Two*.

It's a shame for sure, but perhaps it's understandable in context. Valve has hardly been kicking back taking it easy for the last 10 years — launching and supporting the most successful digital delivery platform in the industry is no mean feat. We should probably cut them a bit of slack and, you know, get on with our lives. Hold on... how about a Kickstarter campaign? A Kickstarter campaign designed specifically to pressure employees into actually making the next headcrab-related adventure? Guys...?

Yes, this really is happening. Two interns at the New Mexico ad firm McKee Wallwork & Company are aiming to raise US\$150,000 to organise a series of events and marketing drives to convince Valve to finally bring *Half-Life 3* to life. Most of the project revolves around mobile billboards and Gabe Newell lookalikes (seriously), but it just goes to show how passionate some gamers are about this series and its seemingly forever-postponed continuation... or denouement.



Beware internet addiction

The world has its first case of medically certified internet addiction. After more than a few stories where people have died from refusing to look after themselves while playing *World of Warcraft*, it seems spending a little too much time in front of screen is bad for you. Well, knock me down with a feather!

In this new case, the patient, a 31-year-old US Navy serviceman, was reportedly spending 18 hours a day on the web before he checked himself into rehab. And the source of all this broadband love? Google Glass. The serviceman — who has, wisely, chosen to remain anonymous — checked himself into the US Navy's SARP (Substance Abuse Recovery Program) clinic, where scientists are treating his disorder. Welcome to the future, folks!

Meet the Alienware Graphics Amplifier

After seeing MSI's GS30 and its chunky GPU dock at this year's Intel Developer Forum, it's good to see that it won't be the only notebook manufacturer to take up the external laptop graphics challenge again. Alienware is launching its Graphics Amplifier to go along with the Alienware 13 notebook, providing desktop GPU performance via a direct PCIe interface. At \$349 for the basic box without an actual graphics card included, that's a pretty penny considering the Alienware 13 itself starts at just a dollar shy of \$1,600. But it means that you'll have a GTX 860M looking after your mobile gaming when you're on the road (for a total of around 40 minutes...) and then a full desktop experience when you plug in at home. A potentially intriguing setup!





\$5,000+

Just how badly do you want an Apple Watch after all?

When Apple CEO Tim Cook unveiled his company's long-rumoured smartwatch project a couple of months back, the only pricing Apple shared was for the entry-level aluminium version, dubbed 'Apple Watch Sport', said to cost US\$349. But the steel and gold options are likely to get more expensive. In the latter's case, *a lot more expensive*. While the steel-based, suffix-less 'Apple Watch' should only carry a minor surcharge at around US\$500, the 18-carat gold 'Apple Watch Edition' is widely expected to sell in the vicinity of US\$4,000-\$5,000 or more (based on the value of the gold alone) when it becomes available later in the year, positioning the device firmly in the luxury wristwatch segment — not the consumer electronics market Apple normally services (nor which APC usually covers!). While this is actually significantly less than the average price tag of something like a Rolex, it remains unclear how, at this not-inconsiderable price point, Apple will counter its smartwatch's inevitable technological obsolescence. When maintained properly, traditional mechanical luxury timepieces last for decades and are passed down through generations as family heirlooms, but it's likely the Apple Watch's 2015-era digital components will be completely outmoded within only a few short years...

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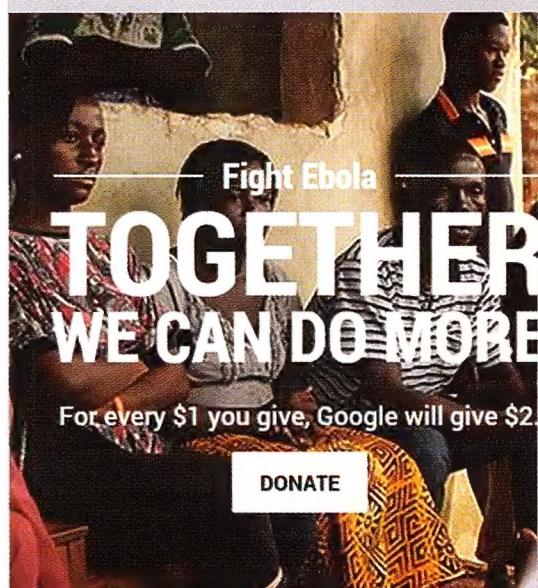
Microsoft's policy shift on Office apps pricing wins big.

In a marked change of direction, Microsoft now lets anybody using its mobile Office apps for iOS — Word, Excel and PowerPoint — edit documents for free, whereas previously editing required a commercial Office 365 subscription. And the gesture provoked an immediate response from users in the US, where the Word app quickly shot to the top of the iTunes Store chart. It seems Aussie users are a little slower off the mark, however; at time of writing none of Microsoft's productivity apps could be found in the Top 100.

US\$20

New Raspberry Pi model costs 250 times(!) less than expected retail price of gold Apple Watch.

At the complete opposite end of the spectrum from luxury smartwatches, Raspberry Pi's new cost-conscious Model A+ redefines cheap computing, offering the foundation's smallest and most power-efficient unit yet, sporting a 700MHz Broadcom BCM2835 CPU and 256MB RAM.



US\$25 million

Google fights Ebola with a generous 2-for-1 deal.

In addition to donating US\$25 million to a range of charitable organisations struggling to contain the Ebola outbreak gripping West Africa, the search giant has launched an ambitious public giving campaign, where it will give US\$2 for every US dollar pledgers offer. Head to onetoday.google.com/fightebola to donate. Thanks to Google's largesse, this 2-for-1 campaign offers a pretty awesome ROI (charitably speaking).

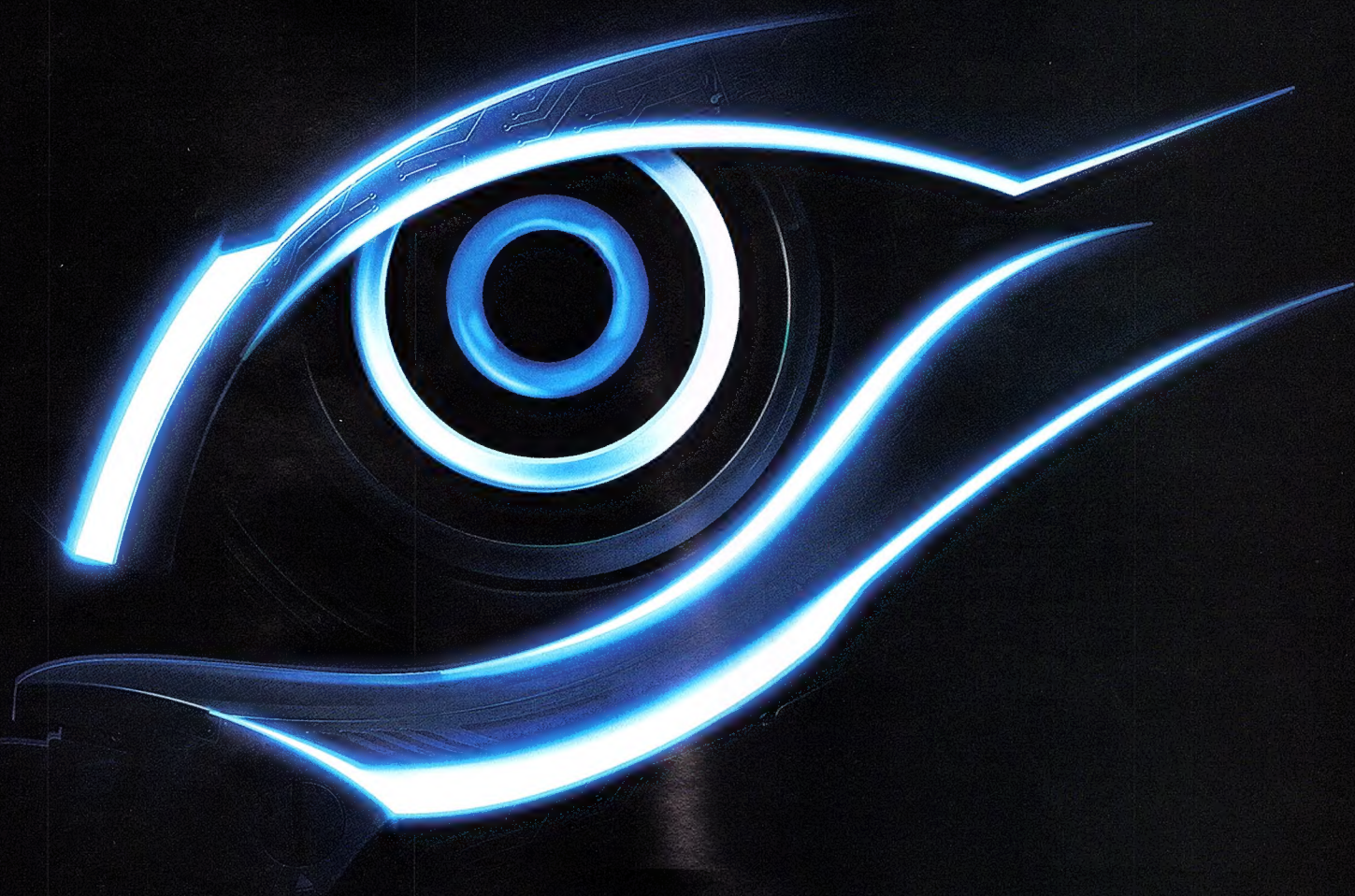
500m

Facebook's divide-and-conquer mobile strategy pays dividends.

Facebook briefly became public enemy #1 earlier this year when it 'unbundled' its mobile Facebook app, stripping the messaging feature from it and forcing users to download the standalone Facebook Messenger app to get in touch with friends (which is, you know, something people generally like doing with social media apps). After a cavalcade of protests and one-star ratings, it seems the masses have grudgingly embraced it, with the company boasting that Facebook Messenger is now being used by more than 500 million people monthly. ■

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technotes

» GEAR WE WANT



NOKE BLUETOOTH PADLOCK

\$89 | WWW.FUZDESIGNS.COM

Following on from the success of its EverDock charging stations for iPhone, Fuz Designs is poised to produce what it calls "The World's First Bluetooth Padlock". The Noke uses Bluetooth 4.0 to pair with your iPhone and, when a wireless connection is made, it will auto-unlock when you press the shackle – no key required. The padlock is water resistant and its battery lasts for a year. You can also set up push notifications so you know if your Noke is being tampered with. A morse code-style passcode provides a backup if you lose your phone or its battery dies.

PARROT MINIDRONES

FROM \$140 | WWW.PARROT.COM/AU

Parrot, creator of the fantastically-terrifying AR Drone quadcopter, has created some slightly more affordable little remote-control vehicles. The Rolling Spider is a small \$140 quadcopter that has large attachable wheels, so it can roll along floors or walls as well as zip through the air. The \$220 Jumping Sumo looks like the weaponised bottom half of a Segway and, brilliantly, it jumps on command. Both can be controlled from your iOS device. Why are we excited? Because we like terrorising people around the office!



OM/ONE

US\$179 + SHIPPING

OMONE.TILT.COM

No, your eyes don't deceive you. The Om/One is a gravity defying Bluetooth speaker that levitates above its base using the power of electromagnetism. The clever base also charges the device, with Om Audio claiming that the final product's battery life should be somewhere in the region of 15 hours. It will be available in three colours too: basic black, basic white, and a glittering disco ball edition. The first batch is sold out, but more should be available early in the new year.

ELGATO AVEA

\$40 | ELGATO.COM

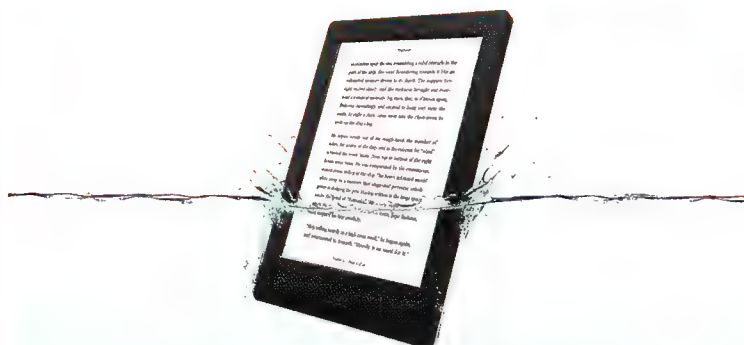
More smart lightbulbs! Unlike bulb sets such as the Philips Hue though, the Elgato Avea doesn't require a dedicated wireless bridge unit to connect your bulbs to your phone, adding to its expense — you just buy a bulb, screw it in and get tweaking. The Avea can display multiple colours, just like the Hue, but it works over Bluetooth Smart (also known as Bluetooth 4.0), meaning that your smartphone connects to the bulbs directly over Bluetooth without requiring pairing. The Avea system looks relatively slick, and we'll be interested to see how Elgato combines them with its other new release — an Apple HomeKit-enabled home automation system. At US\$50 per bulb, it should be cheaper to get into than the Philips system, too. No word yet on an Australian release, but hopefully we'll see these early next year.



KOBO AURA H2O

\$120 | KOBO.COM

Who doesn't love reading a relaxing book in the bath? If you do all your reading on an ebook reader these days, though, this can be a somewhat risky proposition. One soapy slip and your Kindle is driftwood. Kobo's Aura H2O solves this problem by being an ebook reader that's waterproof. How did no one think of this before? Seriously: it's not just the bath scenario. If you take your ereader everywhere with you in a bag, there's a good chance it could get soaked in the rain. If you take it to the beach, it could get splashed. We're surprised the first ever Kindle didn't feature this, to be honest. Still, hopefully this will be the first of many. And it certainly beats keeping your ebook reader in a freezer bag or similar in an attempt to keep it dry.



BLUE MICROPHONES MO-FI

US\$350

WWW.MOFIHEADPHONES.COM

Decent headphones are a dime a dozen these days, but Blue Microphones claims that its new Mo-Fi cans are the first to combine a "built-in audiophile amplifier and ultra-premium drivers to deliver true high-fidelity performance on every device". Together with the amp, the twin 50mm hi-fi drivers can boost and clean music from weak sources such as smartphones and tablets. There's also a passive mode if you want to hook them up to an external amp. These wireless cans should deliver 12-15 hours of audio playback and are available to ship direct to Australia from the US.

technotes

EPINIONS



CODING 101

Thanks very much for your new masterclass on Java in the November issue, it prompted me to Google for Java, Netbeans, etc.

It will not come as any surprise to you that I was swept away by the enormous amount of information coming my way in an almost indigestible quantity.

It is therefore that I look forward to future instalments of your Java masterclass, in the hope that they will be a guide to make this topic clearer to me. Ingesting the vast amount of information in smaller "bitesize" monthly doses will be of great assistance to me as beginner.

Nicolaas

Ed replies: *Learning a new coding language is definitely something that's best done in a measured way — just like learning a spoken language, there's a lot to take in and many new concepts to absorb. We hope you enjoy the rest of the series — and feel free to drop us a line with your own experiences coding Java!*

FINAL PUZZLE PIECE

I was already contemplating building a gaming rig, but your October issue's article had me inspired. I've already got

"Regarding graphics card choice, we'd definitely go with the 970 — in pretty much all our benchmarks, it pipped the GTX 780 by around 3-5%."

the rest of the parts selected: A Thermaltake Black Versa II mid-tower case with 500W PSU (will replace the PSU with a 700W one), an Intel 4690K i5 processor, Kingston HyperX fury 2 x 4GB RAM, a Seagate Barracuda 1TB HDD (after hearing countless stories of how unreliable SSDs can be) and a Maximus VII Ranger motherboard. There's just one problem, I can't decide which graphics card. I've selected two different cards (neither of which are Radeons, due to previous compatibility problems with them): A GTX 970 Windforce card with three DisplayPorts from Gigabyte, or a GTX 780 card from EVGA. Could you please help me decide? Other comments and recommendations would be appreciated as well!

Mathias

Ed replies: *Thanks for the email — we're chuffed to hear that you enjoyed the*

October issue! Regarding graphics card choice, we'd definitely go with the 970 — in pretty much all our benchmarks, it pipped the GTX 780 by around 3-5% and it draws less power. Happy building, it's sounding like a great rig!

XP TO 8, NO WORRIES

I was interested to read the comments from Barry James (November APC) about his Windows XP Acer Aspire One notebook and can assure Barry that it will work well with Windows 8. I also use mine when travelling and have installed Windows 8 and a Samsung 840 EVO 120GB SSD. The 1.6GHz Intel Atom processor used to struggle to load up the original Windows 7 Starter but will boot up Windows 8 in 12-15 seconds. I kept the original hard drive for 12 months just in case, but that proved unnecessary.

Geoff ■

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Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



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The Anonabox anomaly

An ambitious router designed to offer the ultimate in privacy self-destructs spectacularly... and then rises from the grave.

It sounded too good to be true, and perhaps it was. In October an ambitious crowdfunding project surfaced on Kickstarter: the 'Anonabox', a Tor hardware router that promised to provide anonymising benefits like Tor software built directly into the router itself. In other words, a streamlined privacy box, giving you complete peace of mind and anonymity on the web without having to figure out Tor's inscrutabilities for yourself. In its makers words, the Anonabox was "a networking device that provides anonymous internet access and encryption, and helps to bypass censorship in places where access to the internet is limited... an open source embedded networking device designed specifically to run Tor. It's 100% Open Source."

The marketing spiel and resulting internet buzz on the Anonabox paid immediate dividends. Within only days of launching, the Anonabox – which hit Kickstarter with a modest financial goal of just US\$7,500 – had rocketed past the target, with thousands of backers ready to score themselves a magical little router. Clearly, there exists a massive, untapped market for simple, user-friendly privacy technology that doesn't betray our personal information or leave our personal data – meta or otherwise – vulnerable.

Ultimately, the Anonabox had raised more than US\$600,000 before people started noting some inconsistencies in its product description and began

questioning whether the Anonabox was all that it promised to be. Some early backers started to get cold feet, sniping at the project on public forums and withdrawing their funds. Still, by the time Kickstarter stepped in to suspend the project, a hopeful US\$585,549 remained. It seems the Anonabox team had broken a number of rules set in place by the crowdfunding platform.

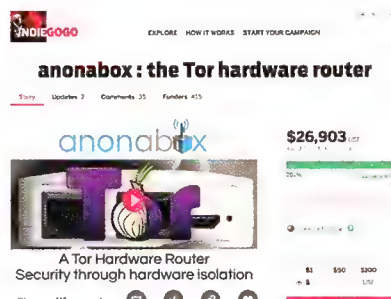
According to an email sent by Kickstarter to the Anonabox team, numerous discrepancies existed between the product's marketing and reality: chief among these was the misrepresentation that core hardware components to be used in the device were 'custom-designed' when in fact they were stock, off-the-shelf units from China. But more importantly, Anonabox's promotional material seemed to suggest the device was a proven, polished consumer product – when in fact the prototype was only a work-in-progress beta model.

But now the Anonabox is back, only this time it's not on Kickstarter. Rival

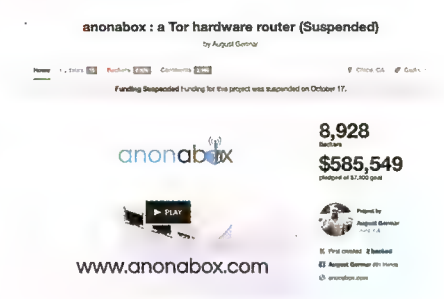
crowdfunding platform IndieGoGo has picked it up, take two, and its chastened developers are upbeat about the first-round backlash, saying: "With [the initial launch] came an overwhelming influx of support and assistance, as well as scrutiny and criticism, all of which have been helpful in reshaping this new launch of a finalised, polished version of the product... Now that we know so many others share our interest in this device we are more excited than ever to get these into the hands of the people who want it."

And perhaps this time the Anonabox developers, who now use their language a little more carefully, will be rewarded with a more realistic level of backing. At time of writing, they've doubled their original IndieGoGo goal, with US\$23,757 so far pledged. Their second-gen device might not have generated hundreds of thousands of dollars overnight, but at least this time users' expectations will be more in line with the tech they're actually getting.

■ Peter Dockrill



Kicked off Kickstarter, will the Anonabox be successful with it's new campaign?



ENDUSER

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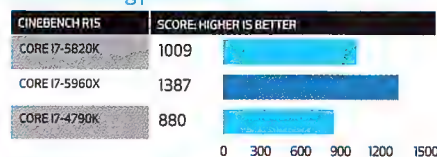


PROCESSOR

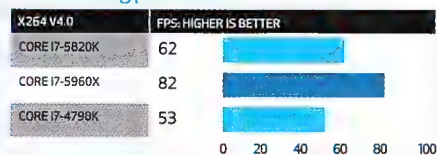
\$470 | WWW.INTEL.COM

LABS BENCHMARK RESULTS

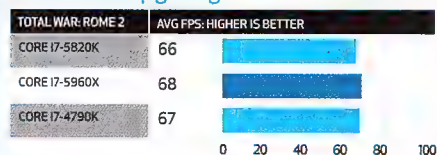
CPU rendering performance



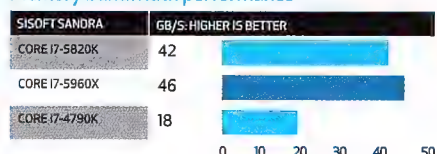
CPU encoding performance



DirectX 11 1080p gaming



Memory bandwidth performance



Intel Core i7-5820K

The missing link between Haswell and Haswell-E has been found...

The top end of Intel's Haswell-E platform is where all the finest new technology from this generation of performance computing lies. When you've got the fastest PCIe-based storage connections, a new gen of DDR4 system memory and a full eight-core consumer processor pulling it all together, that's the pinnacle of today's PC tech.

Quite rightly then, the Core i7-5960X, with its 16 threads of processing power, got all the initial headlines. But for us, this bargain-priced six-core Core i7-5820K is more interesting.

Not everyone can drop \$1,300 on a CPU, so the prospect of the cheapest Intel six-core chip ever is a tantalising one.

The Core i7-5820K is around \$300 cheaper than last generation's six-core i7-4930K – and considerably quicker too. In fact, it's also quicker than Ivy Bridge-E's top CPU, the \$1,400 Core i7-4960X. The 5820K is a CPU

of full Haswell-E stock, sharing the same DNA as the top eight-core 5960X. So, it's still the same 22nm 4th Gen Core architecture and fits in the same advanced X99 platform as its bigger bro.

All you're missing out on compared to the i7-5960X is those two cores, 5MB of cache and 12 PCIe lanes.

With the i7-5820K being just \$60 more expensive than the i7-4790K, anyone who was looking at the top Devil's Canyon CPU for their machine now has an interesting choice to make.

We're not going to pretend that's the only price difference between a decent Haswell setup and the Extreme edition version, but without having to sacrifice any real performance you can build a six-core X99 setup for just \$200 more expensive than a quad-core Devil's Canyon Z97 machine. Prices of DDR4 are high, but when you're looking at dropping 16GB of RAM into your rig – which is something you'd probably want to do if you're going to

utilise the productivity power of the 12 processing threads – there's not a great difference between 16GB of 1,600MHz DDR3 and 16GB of 2,133MHz DDR4. If you go for a basic kit, the difference can be less than \$50.

So if the sorts of things you do with your PC are going to use the processing power that a bona fide six-core CPU can offer, like AV editing and creation or heavy rendering tasks, then the i7-5820K is an incredibly good value piece of technology. The processing and memory performance of the X99 platform is so far in advance of a Z97/4790K combo that the \$200 premium looks like a winner.

But if you're more likely to be cutting down Uruks in Mordor than creating masterpieces in Premier Pro, then the extra expense is likely to be wasted. Current game engines still can't make use of the extra core count of something like the 5820K, and so you don't see any real performance increase for your extra

spend. And don't get us started on what little difference system memory makes in-game.

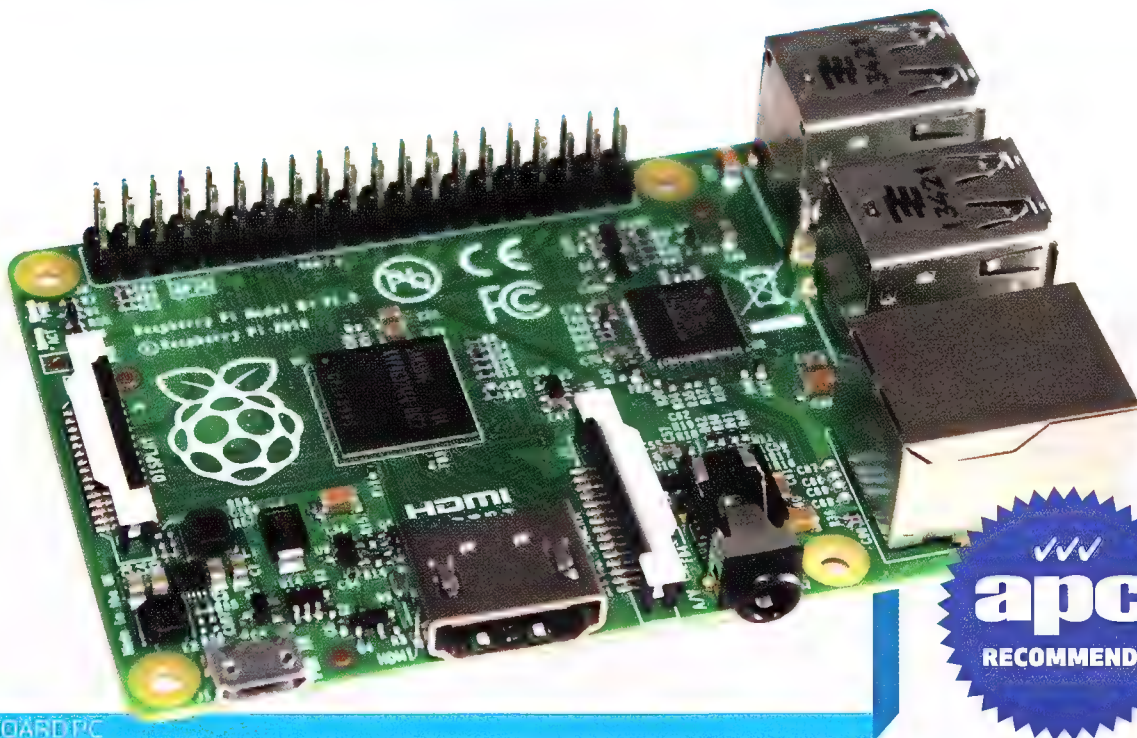
This powerful six-core CPU isn't going to be superseded anytime soon – Broadwell-E has been pushed back to 2016 – and with this platform in place you'll have serious high-end processing power for years to come. **Dave James**

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A bargain-priced, super-powerful processor that will stand the test of time against the quad-core competition.





SINGLE BOARD PC

\$38 | WWW.RASPBERRYPI.ORG

Raspberry Pi B+

We got our hands on the new Model B+ Raspberry Pi. How does it compare with its predecessors?

The Raspberry Pi Foundation has released another single board computer. The Raspberry Pi Model B+ is the final version in the Model B series. (A similar revision to the A hits soon.)

Like previous models, the B+ uses the Broadcom System on a Chip (SoC), the BCM2835 and ARM11 700MHz CPU and 512MB of RAM, but based on community feedback it now has an improved port layout. Ports are no longer dotted around all the sides but concentrated on two, and there are now two extra USB 2.0 ports, taking the total to four. Adding these extra ports has effectively led to a redesign. Next to the USBs is an Ethernet port, as found on the previous Model B, and moving further around there's a single headphone jack, now with analogue audio and video output in a four-pole design.

This removes the need for a separate composite video output and saves space. The analogue audio output has also been improved. Skipping over the standard HDMI port, the last port is a micro USB, connected to a more efficient power circuit that reduces the power consumption by 0.5 to just 1W – we expect this to extend the lifespan of any battery-powered projects considerably.

Another refinement is on the underside: the SD card slot has been replaced with a tactile microSD slot.

You might notice that the GPIO (General Purpose Input Output) looks a little bigger too, the Foundation has added an extra 14 pins to it, taking the number up to 40. Of these 40, the first 26 pins are fully compatible with the original Raspberry Pi GPIO, which means the majority of add-on boards will work with the B+. We did, however, encounter an

issue with both the Wolfson Audio add-on as the B+ lacks the P5 header pins needed for a connection, while the popular PiFace is designed to fit the Model B layout.

James Adams, Director of Hardware for the Raspberry Pi Foundation confirmed that add-in boards designed specifically for the B+ may not work on the previous Model B, but at this time there aren't any that use the full 40 pins of the new GPIO.

The extra pins breakout more of the SoC, giving you more pins for bigger projects and there are two new GPIO pins – pins 27 and 28 – which enable future add-on boards to use an EEPROM chip, and will automatically configure the add-on board on boot.

Any software projects, for example ScratchGPIO or Python, created on previous Raspberry Pi will be fully compatible with the B+ too, so porting your projects over won't be a problem.

The B+ offers quite a lot to Raspberry Pi users, but that doesn't mean the Model B will be phased out anytime soon. Both models will benefit from software changes and upgrades. With a guaranteed future for both models, the Model B+ refines the original design for the better. It doesn't really offer any substantial new features, but does deliver greater potential thanks to the enhanced GPIO and extra USB ports, all for less money and with lower power consumption.

■ Les Pounder

Verdict

Features	★★★★☆
Performance	★★★★☆
Value	★★★★★

With more ports and pins the B+ is a welcome refinement, delivering changes the community were asking for.





SYSTEM

\$529 | WWW.HP.COM/AU

HP ProLiant MicroServer Gen8

We put HP's latest mini server through its paces... and like the results.

The baby of HP's ProLiant server family has been given a Gen8 makeover, with a smart new look and all-new internals to bring it up to current standards.

Intel rather than AMD silicon becomes the order of the day here, with a choice of processor accompanied by up to 16GB of ECC-protected RAM, onboard RAID, a couple of Gigabit network ports and USB 3.0 support. It even gets an integrated HP Lights Out (iLO) management controller, further enhancing the ProLiant's SME appeal.

The Gen8 makeover has turned the ugly MicroServer duckling into a fully-fledged swan with a well-designed and superbly constructed chassis that inspires confidence from the word go. Some things, of course, haven't changed with the same cube format as before and a lift-off casing for ease of access secured by two thumbscrews. The motherboard nestles in the unit's base with storage

above, but the memory slots are easily accessible and the whole board can be pulled out from the back, if needed. Routine access to the storage is via a hinged front door, which can be locked from the inside to prevent tampering, plus there's space for a low-profile DVD drive in the top.

A single power supply with integrated fan is built in with another larger fan at the rear to keep the processor and storage cool. The end result is, however, a little too noisy for an open plan office.

As with previous models, this server has just the one processor socket with three dual-core configurations to choose from. Ours was the entry model, with a 2.3GHz Celeron G1610T (2MB cache, 35W TDP), supported by 2GB DDR3 memory. This we found online for around \$529. Error-correcting memory is specified across the board with just two DIMM slots available, one of which will be populated on the standard models. The maximum you can configure

is 16GB, which is more than adequate for file-sharing but a little limiting if you've virtual servers in mind.

PACKED WITH FEATURES

In terms of storage, there are four slots to take 3.5in SATA drives cabled to an onboard HP Smart Array controller (a B120i). Disks aren't included in the price, however, and the B120i controller only supports RAID 0 striping or RAID 1/10 mirroring which means plugging another card into the single PCIe slot to get RAID 5. This is easy to do, but the cost plus the lack of hot-swap support could rule it out for a lot of buyers.

As well as two front-mounted USB 2.0 ports, there are two more at the back for a keyboard and mouse plus two USB 3.0 ports to either expand the storage or provide for fast backup. Two Gigabit Ethernet ports are also located just above and, for neatness, an optional fanless 8-port switch with port aggregation facilities, which can be stacked

underneath or on top.

Last but not least, there's HP's iLO remote management controller (iLO4) with its own dedicated networking interface on the back panel, which we particularly liked. In fact, there wasn't a great deal we didn't like about the Gen8 MicroServer. The server has to be powered off to swap disks and only two of the bays are able to run full 6Gbps SATA drives, but neither is a major issue in the SME market. Support for more memory would be nice and we would have liked a quieter fan, but that's about it as far as the gripes go.

■ Alan Stevens

Verdict

Features
Performance
Value

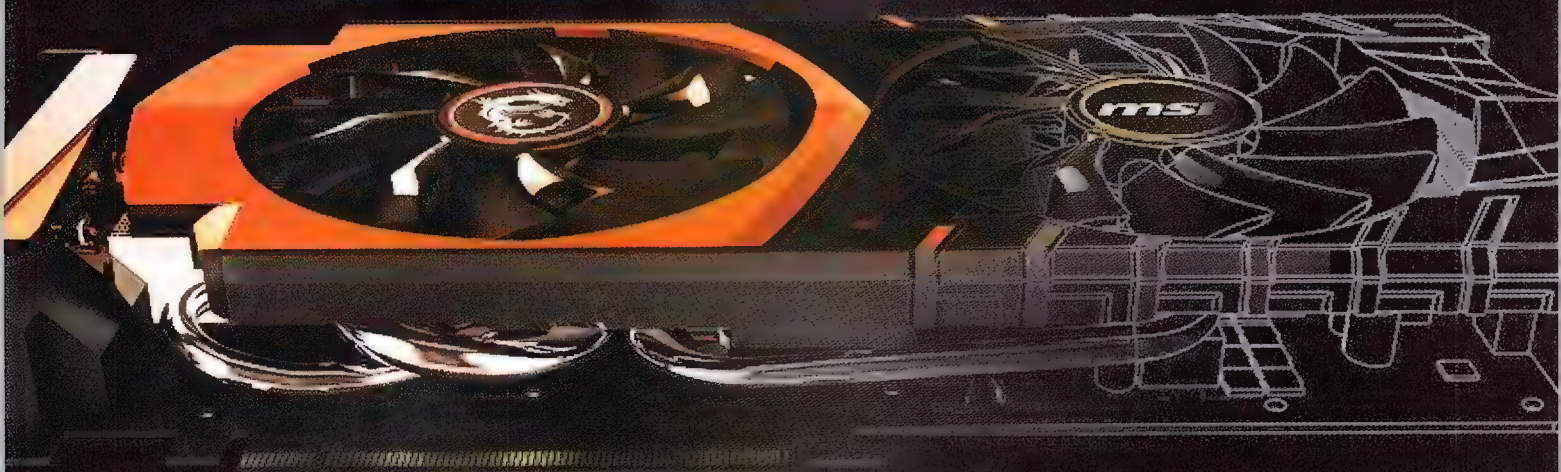


All in all, a very complete product with optional matching network switch, needing little more to finish it off.



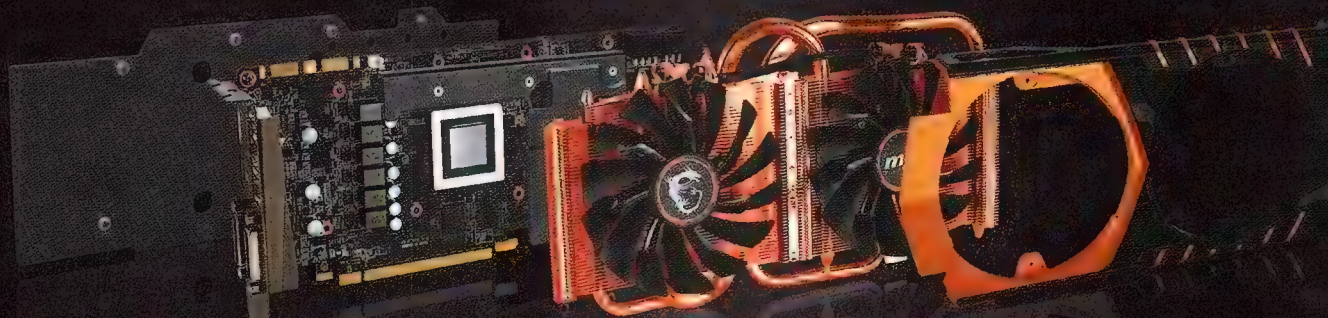


LIMITED GOLDEN EDITION GTX 970 GAMING 4G



The Weapon to Own Your Game!

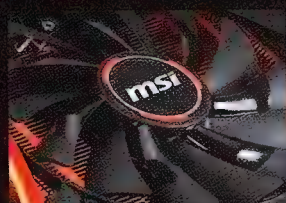
Equipped with Twin Frozr V



Next Gen GAMING Features

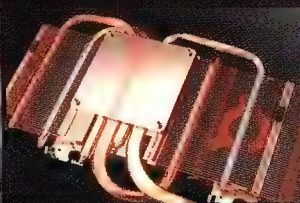
TORX FAN

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GAMING APP

Easy overclocking, fast gaming





GRAPHICS CARD

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LABS BENCHMARK RESULTS

BATTLEFIELD 3		1920 X 1080, ALL SETTINGS MAXED, AVERAGE FPS
SAPPHIRE RADEON R9 290X VAPOR-X 8GB	112	
AMD RADEON R9 290X	105	
NVIDIA GEFORCE GTX 980	132	
		0 25 50 75 100 125
METRO LAST LIGHT		1920 X 1080, ALL SETTINGS MAXED, AVERAGE FPS
SAPPHIRE RADEON R9 290X VAPOR-X 8GB	79	
AMD RADEON R9 290X	73	
NVIDIA GEFORCE GTX 980	82	
		0 25 50 75 100 125
THIEF		1920 X 1080, ALL SETTINGS MAXED, AVERAGE FPS
SAPPHIRE RADEON R9 290X VAPOR-X 8GB	117	
AMD RADEON R9 290X	109	
NVIDIA GEFORCE GTX 980	119	
		0 25 50 75 100 125

Sapphire Vapor-X R9 290X 8GB

Taming the bark of AMD's underdog.

The release of Nvidia's new GeForce GTX 970 and 980 dealt a one-two blow to AMD's competing GPUs. Not only did they provide a slight leg up in speed, they did so at much lower temperatures. Any PC owner who's had to deal with years of incessant fan noise can attest that lower temps equals a more peaceful PC environment, which left AMD's buzz-boxes struggling to gain acceptance. Thankfully, Sapphire has come to the rescue of the still-powerful R9 290X chipset with its creation of the Vapor-X R9 290X, a product that's been tailor-made to lower fan noise. It's also got one other special feature, with 8GB of onboard memory – but whether or not this makes any difference is debatable.

The obvious change is the use of Sapphire's Vapor-X cooler, which replaces the noisy blow-box AMD usually

attaches to the R9 290X. It's a behemoth of a cooler, easily filling two slots in a PC case, and measuring a lengthy 36cm. It's endowed with three fans for removing the heat carried from several heatpipes to a large radiator. Only one fan runs when the card is idling, though there's a hardware switch to enable all three if you're worried about melting the GPU.

Sapphire has also equipped this card with a 10-phase power system, allowing for cleaner, more stable power for overlocks. Speaking of which, Sapphire has also ramped this product at the factory. The GPU clocks in at 1,030MHz versus the reference speed of 1,000MHz, while the 8GB of GDDR5 memory has been bumped up from 5GHz to 5.5GHz, both of which are impressive for the R9 290X.

We were very keen to test just how loud the Vapor-X cooler was under load, and were very pleased by the

results. Under load the fans output just 37dbA of noise, a massive improvement over the 47dbA we'd measured with the stock AMD cooler. This means the card is barely audible when tucked away in a case, and won't interrupt any moody, atmospheric gaming with fan noise.

To test the card's gaming performance, we hooked it up to an Intel Core i7-4770K overclocked to 4.5GHz to minimise any CPU bottlenecking. The first test off the benchmarking rack was the still-stunning *Battlefield 3*. Sapphire's take on the R9 290X had a slight lead over the stock R9 290X, but fell quite a ways behind Nvidia's new GTX 980. Thankfully, *Metro: Last Light* and *Thief* showed much more competitive results, with Sapphire's R9-290X basically keeping up with Nvidia's new uber-chip. Unfortunately we couldn't test the full impact of the extra memory, as we didn't

have a 4K monitor handy. From what we can tell, 4K owners will see around a 10% performance boost – although even at those speeds, the R9 290X isn't quite fast enough to deliver smooth frames at 4K.

Sapphire has done a fine job of debarking AMD's underdog, but at this price it's almost as expensive as some of the cheaper GTX 980 products, which pack extra overclocking potential and a laundry list of useful features such as ShadowPlay, 3D Vision, PhysX and more.

■ Bennett Ring

Verdict

Features
Performance
Value



One of the best R9 290Xs around, but Nvidia's similarly priced GTX 980 is some stiff competition.





"There are no super-sexy, glossy heatsinks adorning the power components. There's no fancy lighting, either – just a very functional basis for a great value, high-end platform."

MOTHERBOARD

\$349 | WWW.MSI.COM

MSI X99S SLI Plus

Is this budget X99 board the perfect match for Intel's Core i7-5820K CPU?

And we've saved the cheapest for last. Actually, that sounds rather disrespectful to a board that we're rather fond of, and not just because it costs almost half the price of the X99 boards we reviewed last month (see APC December, page 66). MSI has done a sterling job with this board, creating an X99 option that doesn't command the huge price premium we've come to expect from this chipset, but neither does it skimp on the features it offers.

There are no super-sexy, glossy heatsinks adorning the power components. There's no fancy lighting, either – just a very functional basis for a great value, high-end platform. Pair this with the cheaper end of the Haswell-E silicon, the Core i7-5820K, and you'll have a high-performance setup that's not too far behind the pace set by the top X99 components, yet costs around a third of the price.

And by 'functional', we mean all the goodness the X99 platform can offer. From a full eight slots of quad channel DDR4 memory, to both top-end PCIe-based storage connections, to three-way multi-GPU support in both Nvidia and AMD flavours, MSI's bargain SLI Plus has the necessary goods.

GREAT VALUE

As you might expect from its lower price point, the SLI Plus isn't going to win any performance awards, but that doesn't mean it's seriously lagging behind the rest. It's competitive with even the high-spec Gigabyte and ASUS boards, always in and amongst the pack. In fact it actually posts higher stock-clocked CPU performance numbers than the Gigabyte X99 SOC Force, which sells at almost twice the price. It's also able to post pretty decent PCIe storage benchmark results too, coming second in terms of the 4K random performance.

Where it didn't perform so well (bottom of the class, in fact) was in the overclocking stakes. Even with a dedicated eight-phase power design it struggled at 4.3GHz with our Core i7-5960X, posting a lower Cinebench score than all the rest. While that would normally be a negative, we're happy to overlook it when the overall cost of the board is so much lower than most of the others on test.

Were it not for the seriously impressive performance of the ASRock X99M Extreme4 – which arrived in our labs a little too late to include in this issue, but which we'll review in full next month – MSI's SLI Plus would hands-down get the nod as the X99 budget hero. As it is though, we're a bit torn over which one we'd recommend for a 5820K-based budget build.

What might just sway you towards the MSI board could be the gaming performance. The average

frame rate is a little behind the rest, but the minimum frame rates are the highest, by quite a long way. That would indicate you're likely to get smoother gaming performance, even if it's a couple of fps lower on average. When the margins are so fine, that sort of benefit could make a real difference to your buying decision.

■ Dave James

Verdict

Features
Performance
Value



A great value X99 motherboard that shows you don't need to spend a fortune to get the Haswell E performance.





apc
RECOMMENDS

MONITOR

\$950 | WWW.AOC.COM

AOC U3477PQU

An upgrade in quality, with a price tag to match.

We're a little over 4K. That first rush of super high-res 4K screens were pretty exciting, but only because they were offering a new resolution we hadn't seen before. Now those 4K screens are securely packed away in the kit cupboard because there's a new wide-boy in town: AOC's U3477PQU.

Our big problem with 4K screens is that there isn't the content yet to justify the step up in resolution and resulting step down in performance. Realistically, moving from a 1440p screen to a 2160p one doesn't currently offer anything other than a drop in frame rates. Your in-game textures are still generally the same scale and won't deliver the visual fidelity promised by the 8MP 4K resolution.

Making the move to a 21:9 aspect ratio though makes a difference that 4K can't yet match. This 34-inch, 3,440 x

1,440 monitor makes for a dramatic gaming experience, but is usable for 'normal' computing too. Early 29-inch 21:9 screens were only 1,080 pixels high, which was far too short to make for a compelling experience outside of gaming. Switching to a 1,440 pixel height though makes even more of a difference than we thought it would.

WIDE AWAKE

The extra demands the super-mega-widescreen native resolution puts on your GPU are nowhere near the frame-rate killing level of 4K. At 2,560 x 1,440 you've got around 3.7MP versus a little under 5MP for the 3,440 x 1,440 res of the AOC. Yes, you will see bit of a performance hit, but not a huge one.

In-game, with that almost wraparound resolution filling your vision, you'll forget about 4K. It's strange, pulling you more fully into the gameworld than the

traditional 16:9.

This isn't the first of the new 34-inch, 21:9 screens we've seen. The LG 34UM95 turned us on to this aspect ratio, but partly because of its Apple-pleasing features like Thunderbolt, it commanded just over a \$1,200 price tag. At around \$200 less, the AOC is a better value proposition. It's still very expensive, but AOC seems to have turned a corner recently and is putting out quality monitors, rather than just cheap ones.

Out-of-the-box image quality has been an issue with past budget AOC screens, but the IPS panel used in the U3477PQU is excellent. The colours and contrast are great as soon as the monitor powers on, and the gradient and white reproduction are similarly good. The black levels get slightly crushed at the lower end, but that is being picky.

The chassis is well made, too. There's a minimal bezel

around the outside of the panel, and the physical buttons on the underside are far easier to use than the touch-sensitive ones some recent screens have shipped with. The OSD is old-school AOC fare, though: functional but little more.

We'd hoped the U3477PQU would be around the same sort of price as AOC's 4K TN monitor, but it's closer to the expensive ASUS RoG Swift PG278Q. That's a shame, but you'll probably forget about that as soon as you start stalking around the new *Alien* with a motion tracker.

■ Dave James

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A great-quality panel, offering a really dramatic upgrade from 1440p, but with a super-sized price tag to boot.





AURUM PT



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1200W



Modularity Design

Easy Installation, neat build



+12V Single Rail Design (Max.100A Output)

Designed for power-intensive VGA cards

Provide strong power to any overloading conditions.



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"Most of the major changes to the Air 2 are actually under the hood — a new tri-core 1.5GHz Apple A8X processor and an upgraded PowerVR graphics processor along with an increase from 1GB to 2GB of RAM."

TABLET

FROM \$619 | WWW.APPLE.COM/AU

apc
RECOMMENDS

LABS BENCHMARK RESULTS

General performance

GEEKBENCH 3.0	SCORE, SINGLE/MULTI-THREADED CPU TEST
APPLE IPAD AIR	1478/2687
APPLE IPAD AIR 2	1802/4545
SAMSUNG GALAXY TAB S 10.5	908/2431

Gaming performance

GFXBENCH 3.0	AVERAGE FPS, T-REX 1080P OFFSCREEN
APPLE IPAD AIR	26.2
APPLE IPAD AIR 2	70.2
SAMSUNG GALAXY TAB S 10.5	22.8

Battery life

VIDEO STREAMING	ABC NEWS 24 LIVE STREAM
APPLE IPAD AIR	11:56hr
APPLE IPAD AIR 2	9:49hr
SAMSUNG GALAXY TAB S 10.5	11:31hr

GAMING	GFXBENCH 3.0 BATTERY TEST
APPLE IPAD AIR	5:50hr
APPLE IPAD AIR 2	4:11hr
SAMSUNG GALAXY TAB S 10.5	4:27hr

APPLE iPad Air 2

The tablet king's latest flagship takes two steps forward, but one step back.

With its latest iPad upgrade, Apple's substantially increased the speed over last year's model, shaved a few millimeters off the thickness, added the excellent Touch ID fingerprint scanner and still maintained a 10 hour battery life.

Compared side-by-side with the original Air though, this new model doesn't look that different — the screen is still a 9.7-inch, 2,048 x 1,536-pixel panel that's one of the best LCD tablet displays available, though it's not as vibrant and rich as the AMOLED one on Samsung's Galaxy Tab S 10.5.

Most of the major changes to the Air 2 are under the hood — a new tri-core 1.5GHz Apple A8X CPU (an enhanced version of what's in the iPhone 6 and 6 Plus) and an upgraded PowerVR GPU along with an increase from 1GB to 2GB of RAM. In performance benchmarks, those new parts add up to

this being the fastest ARM-based tablet on the block — and often by a huge margin. In gaming tests, for example, the new PowerVR GPU can outperform its iPad Air predecessor by nearly 300%; in one benchmark, we saw frame rates increase from 26.2fps to over 70fps.

Synthetic results aside though, that extra power and RAM won't actually do much for you in the near-term. While we found the RAM increase allowed us to keep more browser tabs in memory (you can switch back and forth between six tabs on the original Air before they start to get unloaded from memory, whereas on the Air 2 that increased to 15) and there were slight improvements in load time for some games (around 5-10%), for the most part you'll need to wait for developers to update their existing apps and games — or code new ones — to be able to take advantage of those improvements.

Physically, the Air 2 feels more solidly constructed

than its forebear, despite being thinner. Squeeze the original Air and you'd often find you were pumping, well 'air', out of the top and bottom ports. There's no such problem with the Air 2: its innards are sandwiched together much more tightly, making it feel sturdier and more durable.

The cost of that slim chassis is apparent in one area, though. Teardowns of the Air 2 have revealed Apple's sliced about 15% off the battery capacity in this new model — explaining where at least some of that fat from the original Air's has gone. We ran two battery tests on the Air 2 — a gaming test and a video playback test. In both cases, last year's Air came out significantly in front. The latter was over 2 hours ahead in video streaming (11:57hr compared to the Air 2's 9:49hr) and 1.5 hours in gaming runtime (5:50hr vs 4:10hr). That's a drop of around 20-30%, depending on how hard the tablet's being pushed — and it'd give

us pause when deciding between a cheaper Air (now starting at \$499) and the new model. In essence, what you're choosing between is higher performance and better future-proofing vs longer battery life and a cheaper price.

That's not at all an easy choice to make — the best we can recommend is that, if you're in the market for a new tablet, assess your own usage needs and patterns and choose accordingly.

The one thing we can say with certainty? If you already have an Air, you can probably give this update a miss. ■ Dan Gardiner

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

While the Air 2 is a definite leap forward on several fronts, it does come at a cost to battery life.





TABLET

FROM US\$299 | SHIELD.NVIDIA.COM

Nvidia Shield Tablet

The best gaming tablet in town.

Weirdly bulky but sometimes brilliant, we actually liked Nvidia's original Shield Android gaming handheld. So, with rumours swirling around a slimmer, lighter Shield 2, consider us initially disappointed by what looks like yet another Android tablet. Yawn, right? Nope. Shield Tablet is great at what it sets out to do.

At 8-inches, the Shield Tablet features a gorgeous 1,920 x 1,200 display, the same res as Google's flagship Nexus 7. At 390g, it's around 100g heavier, but still much lighter than the first Shield.

It sports Micro USB, Mini HDMI out, and a MicroSD card slot capable of taking 128GB cards. All of this is running a stock build of Android KitKat (4.4), plus Shield Hub, an app used to buy, download, and launch games. But the real star is Nvidia's new Tegra K1 superchip. The 2.2GHz quad-core A15 SOC features Nvidia's Kepler GPU architecture and 192 CUDA

cores, along with 2GB of DDR3. It supports many of the features in Nvidia's GeForce cards, including tessellation and global illumination.

Until now, the original Shield's actively-cooled Tegra 4 was one of the most powerful Android SOCs around. The passively cooled K1 slaughters it across the board. In 3DMark's mobile Ice Storm test, the delta is an astounding 90%. Up against the 2013 Nexus 7, the Shield Tablet benchmarks from 77% to 250% faster. It's smokin'.

As for battery life, Nvidia claims 10 hours surfing and 5 hours gaming, figures that we found fairly accurate. Of course, if you're going to game, you need Nvidia's new wireless Shield Controller. Sold separately for US\$60, it maintains the same button layout as the original Shield controller, but feels lighter and more comfortable.

While most Android game controllers use Bluetooth, Nvidia opted for Wi-Fi Direct, citing faster response and

better bandwidth. The latter allows linking up to four controllers, which is handy when you hook up to an HDTV via the Shield Tablet's Console Mode and its 10-foot UI. To game on the tablet itself, you'll need to pay extra for the cover and stand. Still, you do get Nvidia's DirectStylus 2, which stows in the device's body and plays nicely with Nvidia's GPU-accelerated Dabbler painting app.

Games wise, the tablet comes with a free Android copy of *Trine 2*, a PC game that looks great following its transition to the Shield. Nvidia says there are now around 400 Android titles that support its controller, but the straight truth is the majority are garbage.

Nvidia, however, has worked with Valve to port over *Half Life 2* and *Portal*. They look fantastic, easily the two prettiest games on Android. Emulators also run as well here as they did on the original Shield. Ditto GameStream, Nvidia's technology for streaming

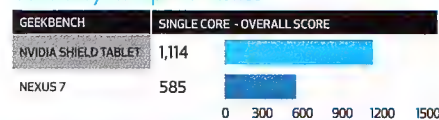
games from your PC to your Shield. Title support is a little limited, but when it does work it's relatively lag-free and kind of wonderful. The one caveat is that you'll have to get a 5GHz dual-band router to really get it working.

Would we buy the Shield Tablet if we owned the original Shield? Probably not. We also think a bundled package with cover and controller would be nice. But it's a no brainer over the 2013 Nexus 7 if you're looking for a gaming tablet... although without any sign of an Australian release, you'll likely need to import one.

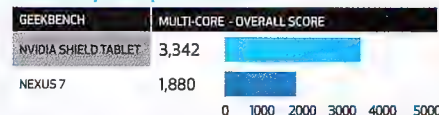
■ Jimmy Thang

LABS BENCHMARK RESULTS

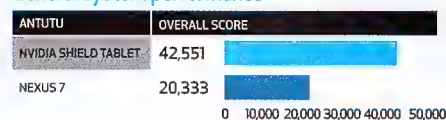
General system performance



General system performance



General system performance



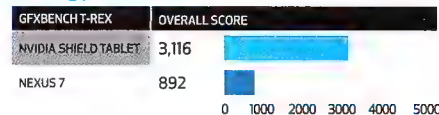
General system performance



Gaming performance



Gaming performance



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Super 8-inch screen; awesome streaming functionality; mega performance.





NAS BOX

\$500 | WWW.THECUS.COM

Thecus N4560

A mid-range smart NAS from Thecus has us considering if we really need a home server any more?

Why choose a NAS over a low-cost home- or mini-server?

With NAS models like this Thecus N4560 the level of functionality you gain is pretty stunning. This model, released towards the end of 2013 but still current, is of interest as it's based on an Intel CE5335 dual-core Atom running at 1.6GHz dubbed the Intel EvanSport platform. Older NAS models have been a bit woolly in performance terms, but the introduction of Intel in the market should eliminate any bad performance.

The Thecus N4560 is a four-bay unit, so we can run a full RAID 5 or 6 with support for up to 4TB drives or 16TB in total. Using the Intel platform has a number of advantages besides CPU power, including Gigabit networking, media handling capabilities, HDMI and S/PDIF out, a video controller, power management, USB 3.0 and DDR3 memory support of which there's 2GB here.

Setting up the device is very straightforward as it uses quick-mount drive bays, which are standardised across the Thecus range. The device will automatically establish a suitable RAID when it's run for the first time. Thecus offers an Adobe Air tool for Mac and Windows users (and a Chromium-based quick-find app for Linux) to locate the NAS on the network and offer up a link. The star of the show is the ThecusOS 6.1 interface, which is trying to be as slick as Synology's, but falls a little short. That being said, it's a fully realised windowed interface accessed through your web browser and it works a treat.

The list of capabilities are somewhat too long to list here but it's pretty much everything you could ever possibly want, from basic user/group quotas and access to Active Directory, iSCSI, NFS and LDAP support. However, other key services include RAID encryption (hardware accelerated), UPS

support (via USB), (S)FTP, UPnP, printer server, Plex/media server, web-based photo server, iTunes support, download manager including torrents, and full backup service including Rsync and Apple Time Machine. It supports being a web server with MySQL and directly mounting ISO files.

Thecus also pushes its XBMC/Kodi playing abilities via the HDMI output, though this didn't seem to want to play ball for us and we'd question how genuinely useful this would actually be. That aside, setting up a RAID is delightfully easy. The interface might not be visually as slick a Synology device but it's functional. The inclusion of the Atom processor should make this a speedy device and we found it to be competitive with straight read/write file copy speeds of 96/78MB/s.

While the Thecus is certainly capable both in terms of speed and feature set, it's not priced that well. At this price for a diskless

setup it's more expensive than the competition: the likes of Synology and QNAP offer similarly priced units with dual LAN or populated with disks. We can't help but feel some of the additional features offered are somewhat surplus to requirements and perhaps push up the price beyond what it needs to be – and we'd also prefer a second LAN port over the HDMI. That aside, if you can snap this up at a more reasonable price then it will be as competitive as anything on the market.

■ Neil Mohr

Verdict

Features
Performance
Value



A solid, fully featured NAS that offers all the software features you want but is overpriced.





HARD DRIVE

\$550 | WWW.DROBO.COM

Drobo Mini (USB 3.0 & Thunderbolt)

Fast, protected, portable storage that grows with your needs.

The basic idea of a Drobo is to buy a drive enclosure then slot disks in as you need them. Your data is protected (depending on configuration, one or two disks can fail and you can replace them without losing a single bit) and once it's full, pop out the smallest, replace it with a bigger one, and increase your storage without missing a beat.

Drobos are available in different sizes and with different abilities. This Mini one costs about \$550 bare, and you can slot up to four 2.5-inch drives — either hard disks or SSDs — into it.

We tested it with four 512GB SanDisk X300s SSDs, a 2TB bundle available in all. Adding these four drives yourself obviously adds considerably to the overall cost, but on the plus side you don't have to add them all at once. You can start with just one and add more as you need them, though if you want redundancy you'll need to add them in sets of

two. Otherwise, this is a terrific little drive that's solid and well designed.

As with all RAID devices, you do lose space for the redundancy (four 512GB drives equate to about 1.3TB) and a little performance, too — we peaked at 530MB/sec over Thunderbolt (half that on USB 3.0), and you can add an mSATA SSD card to speed things up further — but to our minds, the benefits of redundancy and organic capacity increases more than make up for this. ■

Christopher Phin

Verdict

Like all Drobos it's expensive, but it's a sound investment — especially for creative pros working on the move.



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www.plextor.com



PRINTER

\$89 | WWW.CANON.COM.AU

Canon Pixma MG5660

A mid-ranger unashamedly designed for wire-free printing and scanning.

Canon recently refreshed its printer range so this month we're looking at this – the mid-range (yet \$89!) MG5660. There are five ink tanks that can be replaced individually, and the printer can take Canon's XL high yield carts too. Print speeds aren't the fastest we've ever seen (a borderless photo took 45 seconds or so in testing), but you certainly won't be thinking it's a slowcoach, and it's got automatic two-sided printing for documents. Print quality is genuinely very good, with overall vibrant colour reproduction.

Connectivity is key to printers these days, and this is fully Wi-Fi-enabled with the ability to use AirPrint from iOS devices as well as cloud print from services like Google Drive and Dropbox.

With this particular model, you're actually dependent on the Wi-Fi a lot – you can connect it directly

to your PC or Mac using USB, but there's no ability to print from a USB drive or camera memory card. The more expensive MG6650 (\$159) does have memory card slots.

As a scanner, the MG5660 is similarly faultless and you can scan directly to cloud services as a PDF or JPEG – you can also use the handy PIXMA/MAXIFY Printing Solutions app to control this.

If there's one big negative, it's in the fit and finish. It really does feel plasticky and – dare we say? – a tad cheap. It's a good printer for the money, but if aesthetics are your thing, you might want to look further up the Pixma range.

■ Dan Grabham

Verdict

Plenty of features for the money, though steer clear if aesthetics or card slots matter to you.



PC CASE

\$149 | WWW.FRAC TAL-DESIGN.COM

Fractal Design Define R5

Certainly de-finetest quiet PC case we've ever tested.

PC case-maker Fractal's original Define case – the R2 – was launched back in 2010 and quickly earned accolades as a well thought-out design that also happened to be great at silencing a noisy PC – and all at a low price. We've seen a couple of updates to the design since then – that last in 2012 with the R4 – but the R5 is the most radical yet. Much has changed in the PC building arena since 2012; having at least one 2.5-inch SSD has become the norm and setting up water-cooling has become a lot simpler – and more popular.

With the R5, Fractal's kept the clean, modular and easy-to-work-in design along with the noise-dampening material used on the side, front and top panels. What's new is essentially greater modularity, meaning you can easily reconfigure the case to your own needs. And reconfiguring the case is very quick and easy. You can quickly remove all three of

the drive cages (2 x 5.25-inch, 5 x 3.5-inch and 3 x 3.5-inch) into over half a dozen different positions to suit the other hardware you have installed, such as bottom intake fans or water cooler, long graphics cards and so on.

Also admirable is the design of the case's top panels – there's three, and you can remove them each separately, installing extra cooling as required while still containing as much noise as possible. Fractal's also added in the ability to flip the door so that it opens in either direction. Neat.

In short, this is an almost obscenely flexible mid-tower case that it's very hard to find fault with.

■ Dan Gardiner

Verdict

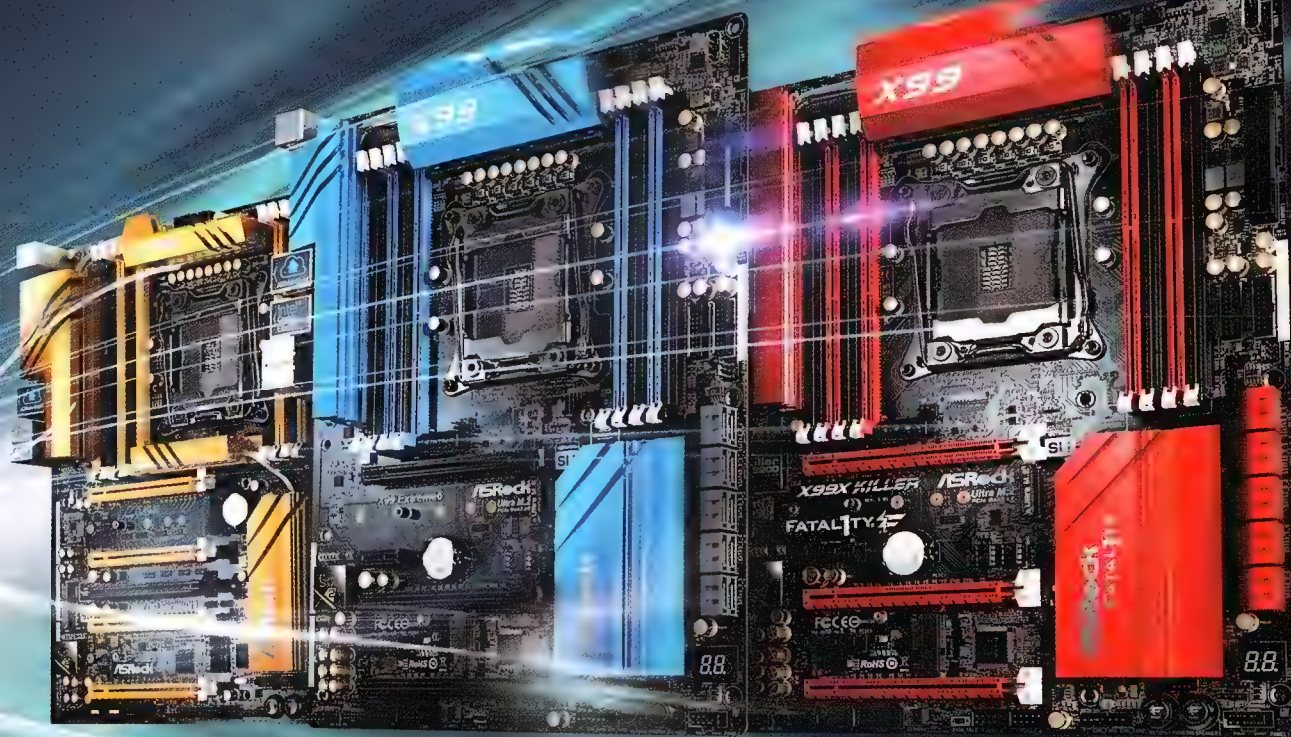
An outstand upgrade to a great case, taking into account all the latest PC-building needs.



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www.asrock.com





GAMING MOUSE

\$50 | WWW.LOGITECH.COM

Logitech G402 Hyperion Fury

The perfect rodent for the FPS crowd.

Logitech has come up with some fascinating claims for its two latest gaming mice. First was the G502 Proteus Core, with the highest possible dpi settings available in any mouse. Now we've got the G402 Hyperion Fury lining up as the world's fastest gaming mouse. How is such technical voodoo possible?

Well, mostly because higher dpi settings don't equate to a faster mouse. This Hyperion Fury is actually only capable of a max dpi of some 4,000; what Logitech means by 'fastest' is how quickly the sensor is able to track physical movement, and the G402 is capable of tracking at speeds of up to 500-inches per second (ips). That's seriously quick. And yes, that is faster than the G502, which has a max of 300ips.

The G402 manages this via a hybrid sensor; it's using both optical sensors and a built-in accelerometer and gyroscope to track the mouse's movement.

Basically, this means it's pretty much guaranteed you won't be able to shift the G402 around your desk quicker than it can track.

And it all translates into a gaming mouse that's incredibly reliable and accurate in the heat of virtual battle. We're usually fans of relatively high dpi mice, yet when you've got such a reliable translation of motion from the mouse to your in-game avatar, you really don't need such extreme sensitivity.

The G402 is a simpler design and we'd be happier having this Fusion Engine strapped into the glorious old Logitech G9 chassis. Still, this is a fantastic mouse, offering great precision and consistency.

■ Dave James

Verdict

Very fast; cleverly designed for accuracy and consistency.



GAMING KEYBOARD

\$210 | WWW.RAZERZONE.COM

Razer BlackWidow Chroma

What you get when you times double-rainbow by 54.5.

Razer's latest BlackWidow refresh is all about looks. While the previous iteration added mechanical switches for predictable performance and greater durability, the new Chroma essentially just adds multi-coloured backlighting – there's now configurable RGB LED-lights underneath each key. You can control the exact hue of each, and pick from a range of colour cycling effects, from waves, to pulses, to reactive that lights when touched.

Otherwise this is a relatively sedate 109-key mechanical 'board, with a matte-black finish and few frills. Mercifully, it's not overloaded with extras, only a bank of five discrete macro keys on the left side.

Though we can't fault the performance of Razer's Green mechanical switches, this is a keyboard with very noisy, clicky keys that will potentially drive others nearby completely mad.

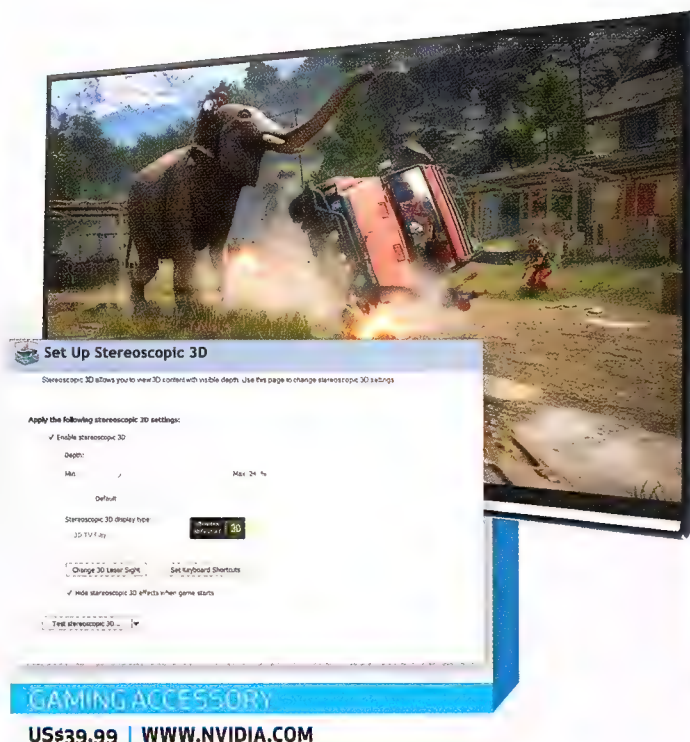
The lighting is actually well-implemented. It's very even, adequately illuminating both the character on the keycap and the 'board surface below. The latter's been painted matte-white so that it better reflects the light. And the config software (Razer's Synapse) makes it quick and easy to pick your desired key colours) and then paint them on the desired keys. You can even completely turn off the backlighting on keys not in use for a particular game, or make configs load with a specific app or game.

There's not a lot to grumble over here, though it would have been nice to see some presets to help speed up configuration. ■ Dan Gardiner

Verdict

That lighting won't appeal to everyone's tastes, but Razer's done a great job implementing it.





Nvidia 3DTV Play

The software add-on that aims to bring stereoscopic PC gaming to your big screen.

Nvidia's stereoscopic 3D Vision gaming tech – requiring a special 3D-capable monitor and a pair of Nvidia's 3D Glasses – has been around for a while, and with the right titles it does create an impressive experience.

Less well-known is that Nvidia also sells a version of this tech aimed at regular 3D TVs, and even lets you utilise your TV's own 3D glasses. With basically every TV now 3D-capable, we thought we'd take a look at how well it works.

The answer is... mostly OK. The product simply adds a license on your PC and then, using the installed Nvidia drivers, a wizard guides you through using the TV's 3D glasses. And that's about it – at least in theory.

We ran into a few foibles because we were initially using DisplayPort to hook our gaming rig up to our TV. This is the ideal output, but until we switched to HDMI, the wizard wouldn't let us set up the 3D glasses.

Then, another hurdle: picking 1080p resolution at 60Hz was also apparently not on – 3DTV Play only supports 1080p at 24Hz, or 720p at 60Hz. It's akin to choosing your dream birthday cake, and then being told you can't have any. 1080p at 24 fps is painful and, while smooth, 720p at 60 fps looks like a trip back to *Space Invaders*.

Does 3DTV Play work? Yes, and quite well depending on the title. But the resolution and fps limitations make it more an interesting exercise than something you'd want to use a lot. And for this privilege, Nvidia wants US\$39.99.

Nvidia needs to fix those limitations to make this worth paying for.

■ Ashton Mills

Verdict

A limited and pricey way to get 3D PC gaming on your TV.



Sony Xperia Z3 Compact

Small exterior, big(ger) interior.

Sony's Xperia Z3 Compact crams everything we like (and dislike) about the Xperia Z3 into a smaller frame.

That means fingerprint-prone panels of glass on the front and back of the phone, joined by a functional frame – though it's plastic here instead of its bigger sibling's aluminium. The Compact is slightly thicker than the Z3 in order to fit all the 5.2-inch latter's bells and whistles behind a smaller 4.6-inch display. And that IPS screen looks great. The 720 x 1,280-pixel resolution may sound underwhelming compared to other 1080p flagships, but the display's modest physical dimensions mean you won't notice the drop in pixels. Images are sharp and bright, and the screen makes the most of its real estate by taking features from Sony's VAIO range and Bravia TVs – namely the Triluminos and Live Colour LED technology. Direct sunlight poses no problem, and to our eyes the

Compact's viewing angles seemed slightly better than its big brother's. The dust-resistant and waterproof chassis (to IP65 and IP68 standards) contains a far-from-slouchy 2.46GHz quad-core Snapdragon 801 processor, Adreno 330 GPU, 2GB RAM with 16GB internal memory. Running Android 4.4.4, it can tackle graphically intensive games without breaking a sweat. The 20.7MP camera is reliable if perhaps unspectacular. Outdoor shots deliver more natural skin tones than the Galaxy S5, but we wish indoor shots had more detail. Battery lasted 10 hours in our streaming test, and you'll get a day and a half in the real world.

■ Rob Edwards

Verdict

The Z3 Compact successfully delivers smaller dimensions without sacrificing on specs.





BULLETPROOF SECURITY FOR THE DIGITAL AGE

PROTECT YOURSELF AGAINST MODERN ONLINE THREATS WITH ESET'S METICULOUS SECURITY SUITE.

As the internet has ushered the world into a new age of digital connectivity, it's also enabled attacks from increasingly sophisticated malwares and security exploits. With threats ranging from software that steals your identity or compromises your data to worms that turn your computer into a spam-sending zombie, cutting-edge protection for your computer is now must have. Back in 2000, the ILOVEYOU virus infected over 50 million computers, overwriting files and costing billions of dollars to clean up. In more recent times, worms such as Storm and Conficker took over millions of under-protected computers to form a botnet that can send spam or sell its services to the highest black-market bidder.

It's not just deliberately constructed malwares either – earlier in 2014, the Heartbleed bug allowed for theft of passwords and private data from around half a million supposedly secure web servers, potentially affecting millions of people. Tomorrow's attacks could be even worse, so what steps can you take now to better secure your personal data and online identity against the latest threats?

FORTIFY YOUR COMPUTER

Security software has a tendency to be reactive - focusing on detecting breaches and then cleaning up the mess. While this is a good start, it's better to be proactive and stop any attacks before they can get a digital foot in the door. ESET Smart Security 8 and NOD32 Antivirus 8 includes an enhanced Exploit Blocker just for this task – fortifying your system and applications from attack. Focusing on vulnerable areas such as web browsers, PDF readers, Java, email clients and Microsoft Office components, the exploit blocker works to enhance your overall security. It also targets and blocks attacks that have been specifically designed to evade antivirus detection.

GONE PHISHING

Data security is about more than just stopping viruses and malwares, of course – phishing emails are an increasingly common online attack vector, attempting to steal your personal information by masquerading as a trustworthy entity. Passwords, bank account details, credit card numbers and other sensitive personal information are all at risk. Phishing can also be hard to combat, as your computer need not be infected for you to fall victim. To help protect against these sort of attacks, ESET Smart Security 8 and NOD32 Antivirus 8 include an anti-phishing module that automatically blocks known phishing sites and pops up a warning. To protect against new threats, the software will also inspect the design of web pages and is able to detect sophisticated mimics, such as a rouge web site masquerading as an internet banking form.

THE TOTAL PACKAGE

With new exploits and attacks constantly surfacing, you need an antivirus system that stays cutting edge. If you've ever read a hasty Facebook message from a friend telling people not to click on the link they just sent, you will appreciate that ESET Smart Security 8 and NOD32 Antivirus 8 has a built in social media scanner. It can also let you know which of your private data is visible online and helps you lock it down via your social media security settings. You also want the basics covered - the ESET software has a very low system footprint to maximise performance and offers both simple one click solutions for easy setup and detailed settings that let you totally customise your security profile.

NEW
EDITION

The Internet
saved my life

– Marcie, Dancer

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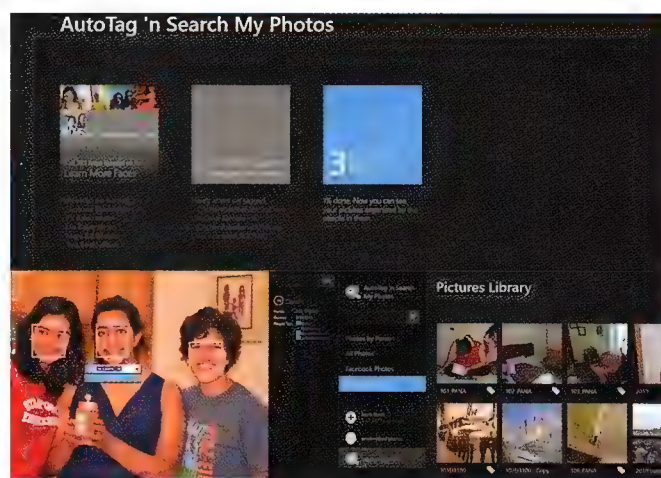
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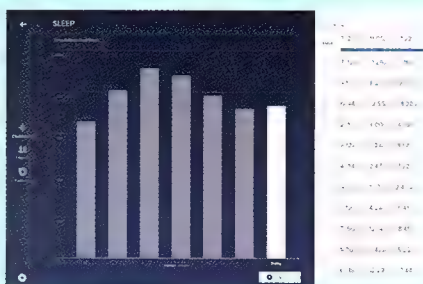
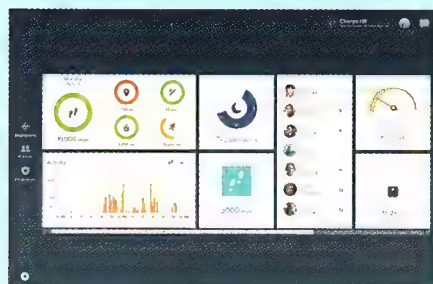


Whether you're a 'digital native' or a 'digital immigrant' — which, in case you weren't aware, is the term now being applied to anybody born before 1985 — there's one thing we're all doing a lot more of these days, and that's taking photos.

While the cost and inconvenience of getting film developed prevented casual photographers in times past from over-shooting their rolls, these days there's nothing to stop us taking more and more (and more) snaps on our smartphones and digital cameras. Which is a totally fine thing all round... until you realise your photo folders and libraries are a sprawling, chaotic mess of disorganised image files. Luckily, the advent of facial recognition software, like Microsoft's new AutoTag 'n Search My Photos (from the company's experimental Microsoft Garage initiative), makes tidying up your photo collection a relative cinch, tagging faces it



recognises from your Facebook network and applying them instantly to the rest of your personal pics. It might take a bit of legwork to get AutoTag up to speed on who's who, but a little time spent helping the app to identify different faces among your friends and family now will save a lot of time later on if you ever have need to find a particular shot.



Fitbit

FREE | FITBIT | [TINYURL.COM/MU8XXR3](http://tinyurl.com/MU8XXR3)



For nearly two years now I've been a convert to the Fitbit faith — or is it a cult? — and while I originally picked up my diminutive fitness tracker on a whim, with two years of my health analytics now logged on the platform it's actually become a rather fascinating personal archive of how active I've been (or, at times, not). Using both a Fitbit Zip, the company's entry-level steps tracker, and a Fitbit Aria smart scale, which uploads my recorded weight and body fat percentage to the cloud every single time I step on it, I've tracked my activity and weight since January 2013. If you're interested in monitoring these kinds of health metrics, having these relatively inexpensive gadgets — OK, so the scale is actually a bit pricey — keep tabs on everything for you provides a much more objective assessment of your progress over time than anything else will (short of hiring a professional personal trainer). The Fitbit app for Windows 8 has recently been through a significant overhaul, and while it still doesn't offer much functionality beyond the default Fitbit web app accessible via any browser, Fitbit's contemporary Dashboard view does gel very nicely with the stylings of the Windows Modern UI. Check it out.

Halo Channel

FREE | MICROSOFT STUDIOS | [TINYURL.COM/NQJKNHQ](http://tinyurl.com/NQJKNHQ)



For any Halo die-hards addicted to all things Master Chief, the Halo Channel for Windows 8.1 (and also on Xbox One) may well become a compulsory destination. Billed by Microsoft as "an all-new interactive digital network that provides unprecedented, personalised access to the Halo Universe", the Halo Channel is essentially a marketing hub accompanying the release of the new Halo: The Master Chief Collection with ties to other brand media properties such as Halo 4: Forward unto Dawn and Halo: Nightfall. Definitely worth a look for fans of the series.

Airmail 2

Better than OS X Mail?

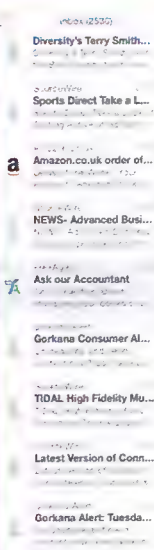
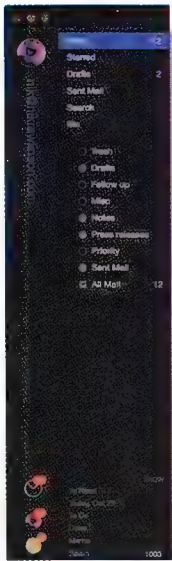
\$12.99 | BLOOP SRL | AIRMAILAPP.COM



Airmail 2 wants to usurp Mail. It's attractive, fast and extensible... but it comes at a price. Mail is free, so

Airmail will have to work hard to beat OS X's default option.

Getting set up is a breeze, importing accounts from earlier versions with three clicks and auto-detecting server settings for any new accounts you need to add from scratch. As before, it's compatible with most webmail services, plus iCloud, Pop3 and IMAP, and you can now link it to web apps such as Dropbox and Google Drive, which it can use to host attachments. It sports iOS Mail-style mouse gestures, so you can swipe left and right to delete or archive messages, and convert them into Reminders or Calendar entries through a menu in their titles. If your day starts with an email audit, these tools help you complete the task sooner, and you can further automate the process using the extensive Rules panel. Notification Center integration puts Airmail in Yosemite's Today pane,



Ask our Accountant

FreeAgent To: mia@myfreeagent.com

FreeAgent

Log into your account

Lunchtime Live: Join the Q&A!

Got a question about bookkeeping or using FreeAgent?

- Can I claim tax relief on my train ticket?
- How can I save time on my bookkeeping?
- Which details do I need to include on my invoices?
- How do I file my Self Assessment in FreeAgent?

Ask our Chief Accountant Emily at our live Google+ Hangout on Wednesday

Don't worry if you can't make it, you can post a question in the Q&A tab and we'll answer it during the session - you can pop back to watch the recording

Hope you can join us!
The Team at FreeAgent

When: Wed, October 29 12:00pm - 12:30pm
Where: Google+ Hangout

Save your spot

FreeAgent Central Ltd
40 Forthglen Street, Edinburgh, EH3 5JG
Registered in Scotland SC318774
VAT Registration Number 418385008

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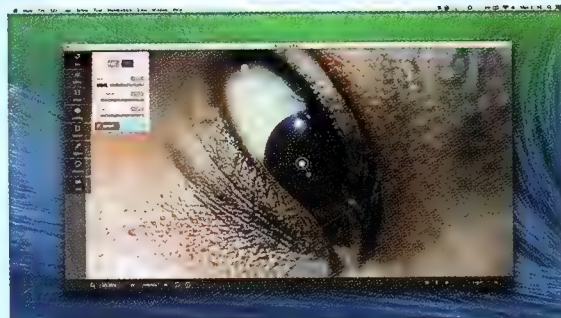
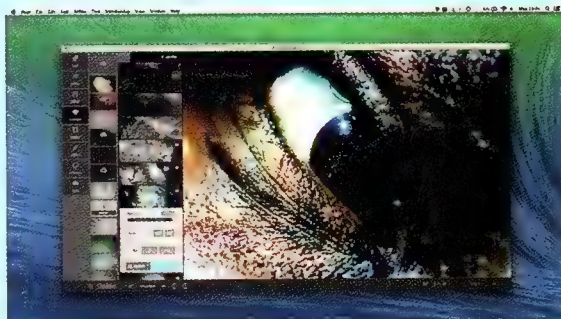
where you can see not only your unread messages but any you've marked for follow-up as 'memos' or 'to-dos'. The new plug-ins system lets you expand its default features. It's easy to add extras like Google Translate and encryption, but it's still lacking smart mailboxes. We like Airmail - a lot - but despite the improvements in this latest release and its low price, it's not going to replace Mail on our Mac just yet. With smart mailboxes, that judgement may very well be reversed.

Autodesk Pixlr

FREE WITH IAP | AUTODESK | PIXLR.COM



Pixlr has existed as a browser-based image editor for a while, but Autodesk (of AutoCAD fame) has now made it free - initially - as a desktop app. The Starter edition is free to download, and contains useful tools such as crop, straighten, red-eye removal and a handy healing brush to remove spots and blemishes from your photos. Sign up for a free account, and the app morphs into its Essentials edition, which adds a few more options and a clever double exposure mode that blends two images. Give Autodesk some money in a yearly subscription, however, and you receive the Pro edition, which brings the ability to apply effects within selections rather than to the whole image. Any version will give you the Stylize and Overlay menus, which you can use to create some striking art. Their array of one-shot filters and images that blend with your original need to be downloaded before they're available, which helps keep the app size down and doesn't affect your workflow too much provided you're connected to the internet, and can be previewed before they're applied. There's no Save option, only Save As, so your creations will always be exported as a new file. It feels churlish to criticise free software for a lack of features, but such a criticism isn't appropriate here. While not comparable to the featureset of say, GIMP, the ability to crop and straighten, then apply filters or otherwise jazz up images, is popular and, although Pixlr doesn't have direct connections with social media, sharing on Facebook is just a few clicks away. Pixlr won't replace Photoshop Elements, but it's powerful enough, has some interesting features and, importantly, is free.





App Store » iOS APPS



Autodesk SketchBook

A 2D paint package that does more than you might expect.

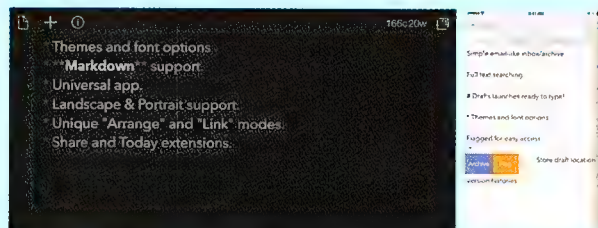
FREE WITH IAP | AUTODESK | WWW.SKETCHBOOK.COM



For a company best known for 3D software (including the wonderful 123D apps), Autodesk's latest release is all about the flattened screen.

Now known simply as SketchBook (prior versions have included Mobile, Express and Pro), Autodesk wants to give you the tools to create and output your digital drawings and paintings... so long as you're prepared to unlock them through the medium of an IAP. That's the major change, here; SketchBook has one In-App Purchase to unlock the tools you'll need (which, understandably, hasn't gone down well with prior fans). After that you'll find all the traditional tools of a well specced art application: layers allow you to organise your outlines, colours and shading and an increased range of blend modes allow you to create all new effects. There are more brushes than ever to add to the fun of drawing (but some are still too low-res to use on the larger image sizes available). All told, this isn't as huge an update as a new name and app slot might suggest, but one major change — the double puck — does shrink the user interface and speed up workflow brilliantly. It's not a brand new SketchBook then, but it remains a powerful and well featured drawing app.

Paul Kercal



Drafts 4

\$9.99 | AGILE TORTOISE | AGILETORTOISE.COM



Drafts is an iOS app built around capturing and sharing text. Open the app and you get a new page, ready to be filled. You can then start typing, and when done use built-in or additional actions to send your text elsewhere. This is nothing new, but what sets Drafts apart from the competition is its flexibility. Its rich features feel more akin to the now-closed Editorially app than a typical notes app. The keyboard strip above the predictive text bar is fully configurable, and you can compose your own actions to craft bespoke workflows. An arrange button enables you to rearrange paragraphs, and there's also Share sheet and iOS Document Picker support that boosts general system integration. Getting text into the app is a mite fiddly — web capture is basic, and there's no means to open existing text files from within Drafts — but this is nonetheless a versatile tool.

Craig Grannell



Translator Keyboard

\$2.49 | STEVEN BARNEGREN | WWW.STEVEBARNEGREN.COM



Translator Keyboard is one of the newly available third-party keyboards for iOS 8, and will likely appeal to anyone who regularly contacts speakers of other languages. To use it, simply swipe left to select your 'from' and 'to' languages, then type your message. Hit the button and let it work its magic, using the Microsoft Translate API. As a keyboard, Translator Keyboard is slightly on the unresponsive side, failing to register some key taps, which can mean frustrating errors. As with any machine translation system, the translations themselves can be a bit wobbly — especially between languages with significantly differing word orders. It's probably wise to have a smattering of knowledge of the language you're translating into so you can avoid obvious gaffes. For \$2.49, though, we don't expect miracles, and this handy tool will hopefully improve in tandem with the translation database.

Lise Smith



Google Play » ANDROID

Flipboard

Flipboard

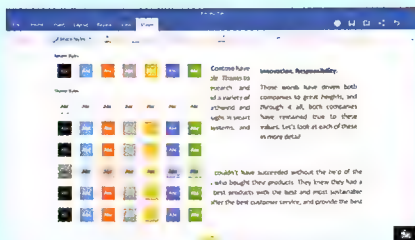
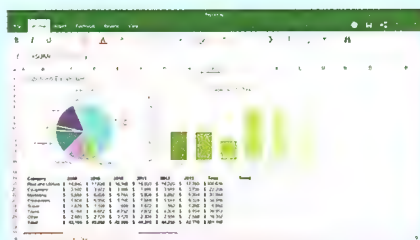
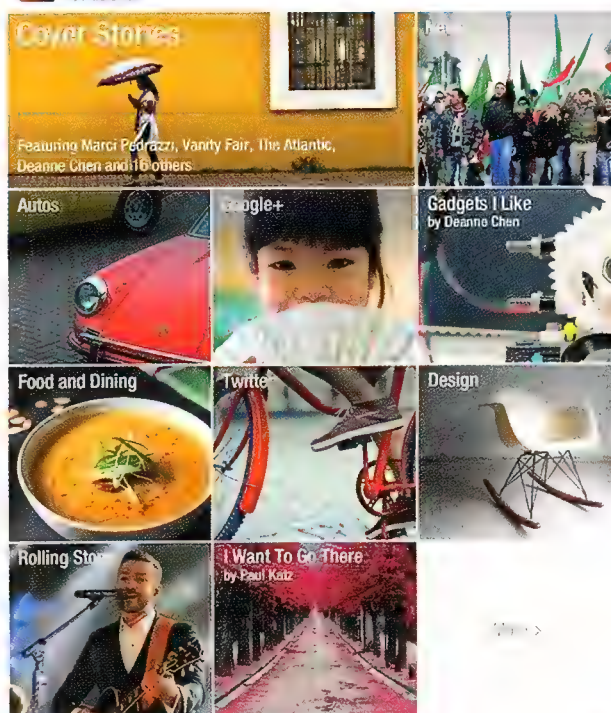
Flipboard turns 3.0 and celebrates with some functional new bling.

FREE | FLIPBOARD | TINYURL.COM/AWOE78K

F We've covered Flipboard many times in APC because it's one of the most prominent and progressive media reader apps available in the mobile space — and with over 100 million users getting their news fix on the platform, we're clearly not the only people who love to flip.

Still, it's not every day Flipboard turns a major milestone, as it has recently with its just-launched 3.0 edition. The new Flipboard doesn't do away with any features regular users should be familiar with, but it does bring in four new key functionalities. First and foremost, a new topics finder, with some 30,000 key areas listed, ought to help new users populate their book. Second, although not currently live in Australia, a new Daily Edition feature rounds up all the latest headlines, curated by editors, not algorithms (hopefully this turns up here soon). Also, a new navigation bar for smartphone (not tablet) users makes it easier to get around the app and see highlights and updates from the sources you follow, and people who like to make their own magazines on the platform are now offered analytics. Lastly, we'd have to say performance seems smoother than ever; Flipboard wasn't a slouch before, but version 3.0 positively sings on our Android test unit. Great stuff.

Lauren P.
10 magazines



Office for Android tablet Preview

FREE | MICROSOFT | TINYURL.COM/O2QWFK3

O It's not available just yet, but if you've been waiting for an optimised version of Microsoft Office for your Android tablet, we have some very good news. The Windows maker has announced that it's (belatedly) putting the finishing touches on its Office for Android tablet apps, and keen beans can sign up for a Preview as we speak, with general availability slated for early 2015. It's expected that the new standalone Word, Excel and PowerPoint for Android will be similar in looks and functionality to the iOS versions kicking around for the past year, and happily Microsoft has just changed its stance on mobile pricing: users will now be able to edit — not just read — documents with these free apps, whereas previously a commercial Office 365 subscription was required, although a 365 subscription will still unlock additional features. Note, to be eligible for the Preview you'll need to be running a pre-Lollipop Android OS. In the meantime, if you're really desperate while you're waiting for your name to be called, you can always check out the existing Microsoft Office Mobile app for Android (tinyurl.com/nk7d34k), but be aware that this older release is getting a bit long in the tooth now and will soon be replaced by the new & improved fleet.

Photo Editor by Aviary

FREE | AVIARY | TINYURL.COM/9CR940X



Adobe acquired Aviary, the makers of the well-regarded Photo Editor by Aviary, just a few

months ago, and it's already set about making some robust updates to the app. Most remarkably, in a bid to spruik Adobe's Creative Cloud, the companies announced Photo Editor's substantial IAP catalogue — some US\$200 worth of effects, filters, frames, stickers and whatnot — could be unlocked entirely for free for anyone who logged in with their Adobe ID during November. Don't be miffed if you missed out on the goldrush though. Even without any of the add-ons (some of which are a tad gimmicky), this is an excellent, powerful image editor with a great default toolset. Worth checking out.



Windows Store » WIN PHONE 8

Movie Creator Beta

Lights, Lumia, action.

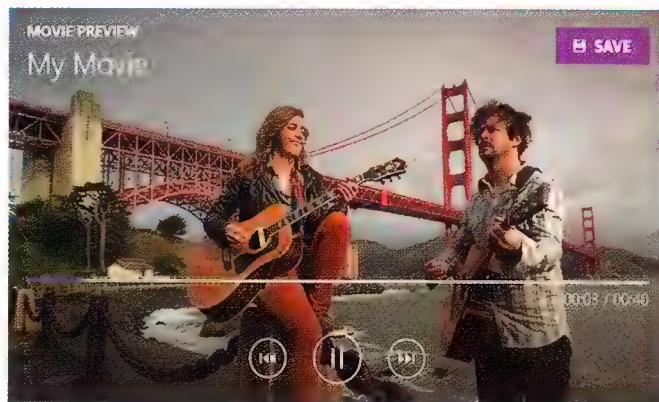
FREE | MICROSOFT MOBILE | TINYURL.COM/PMUU69W



Despite what device manufacturers and mobile software developers would have you believe, nobody involved in creative media production dispenses with their PC entirely; despite the gains in content-making apps and the power of newer mobile devices, most professional media makers still inevitably turn to PCs and Macs to get their hard yakka done. But we are still seeing a rapid evolution in the sophistication and power of mobile apps. A few years ago, the early touch-based smartphone apps didn't offer a fraction of their current functionality – but for today's casual users or determined professionals (with a point to prove) or people who simply don't actually own a PC, there's now a whole alternative software ecosystem that enables users to make real stuff using just their phones.

Case in point: Movie Creator Beta, which only recently issued from Microsoft but already has been met with a rapturous reception, and for good reason; this is a fun and extremely easy-to-use video-making program that enables you to edit, mix and produce short films entirely on your smartphone. You can add music and filters, apply credits, pan & zoom and much more; inevitably, a couple of theme packs are included with additional ones available via IAP. Is it what Christopher Nolan uses? No. Will it suffice for your next holiday best bits montage? Effortlessly.

While Movie Creator Beta isn't designed to take on the recent micro-movie craze popularised by social apps like Vine, you could easily use it to create super-short creative snippets if you wanted and then upload to your chosen network. Or of course you can



EDIT MOVIE

My Movie

add footage

add text

select theme

select music

enter title here

enter credit here

produce much longer content. Microsoft points out MCB edits can range from a few seconds in length to up to a few hours, so the only limit is your imagination (oh, and your device's storage).

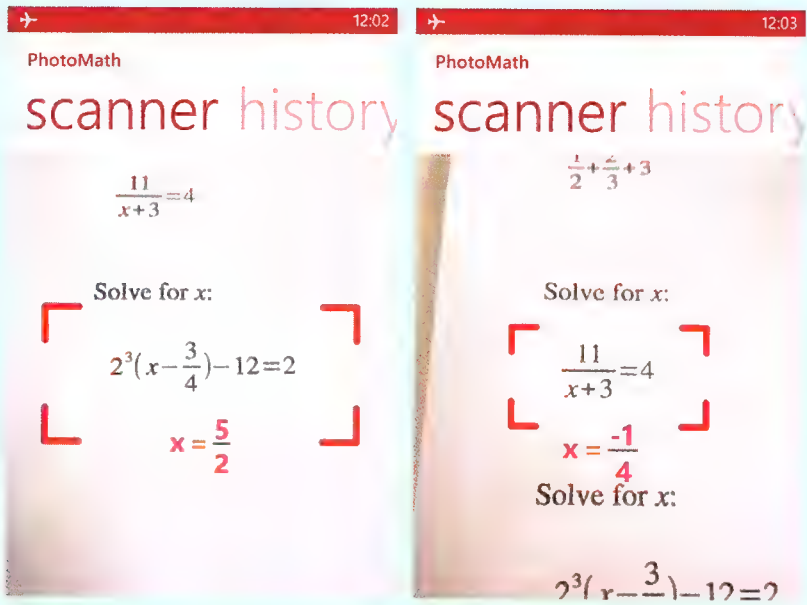
Movie Creator Beta requires Windows Phone 8.1 and unfortunately... it's a Lumia exclusive. We could understand the former value-adding rationale of Nokia-developed software previously only supporting Lumia devices, but now that Microsoft has absorbed the Lumia line wholesale, it really ought to stop excluding and effectively penalising Windows Phone users who've opted for hardware from other handset makers. It's only fracturing an already delicate user community, no?



PhotoMath

FREE | PHOTOPAY | TINYURL.COM/KKLEFKC

PhotoMath is the kind of brazen technological innovation set to strike fear into the heart of the nation's educators: the "world's first camera calculator" enables students to simply snap a photo of any troubling mathematical problem and the app does the rest, providing the correct answer. On the bright side, PhotoMath doesn't just offer streamlined solutions to cheaters; it also offers step-by-step explanations, making the app a promising teaching or study aid. It's not perfect. For PhotoMath to do its thing, questions need to be typed, not handwritten, and the focal detection can be a bit touchy. But nonetheless, further inarguable proof if such were needed that (image recognition) software is (knowingly) eating the world.



HP OMEN AT A GLANCE

- 4th gen Intel® Core™ i7-4710HQ processor
- Microsoft Windows 8.1
- NVIDIA GeForce GTX 860M graphics with 4096MB of dedicated video memory
- 15.6-inch diagonal Full HD WLED-backlit display (1,920 x 1,080) touchscreen
- Up to 16GB 1600MHz DDR3L SDRAM
- Up to 512GB solid-state drive
- Per-game assignable profiles
- Definable dedicated gaming keys



INTRODUCING THE NEXT GENERATION OF GAMING

HP *Omen*

HP is well-known for its huge variety of business and consumer laptops, but it's probably not the first name you think of when it comes to gaming. That's all about to change, with its new line of Omen laptops, starting with this super-sleek 15.6-inch model. Under 2cm thick and only 2.3kg, its black-and-red design is thin and light enough to carry around as your everyday laptop. But hidden inside its slender exterior is solid gaming prowess: the Omen 15's 1080p display is powered by a speedy NVIDIA GeForce GTX 860M graphics processor, backed up by a quad-core Intel® Core™ i7-4710MQ processor and

up to 16GB of memory. And you won't be sitting around waiting for your games to load either, with the option of up to a 512GB SSD for blisteringly-fast storage – there's also ample space for all your games. The Omen 15 is well-equipped elsewhere too, with class-leading Intel 2T2R 802.11ac Wi-Fi, and HP's still managed to jam in a generous serving of four USB 3.0 ports, giving you plenty of options for plugging in high-speed drives and other peripherals. In short, it's not wanting anywhere. If this is a portent of things to come from HP's new gaming line, it looks like a very good omen to us.

GET THE ULTIMATE GAMING MACHINE AT HP.COM.AU/OMEN

2-in-1s take flight

Can't decide between a new tablet or a new laptop? Bennett Ring tests 10 new devices that aim to give you the best of both in one package.

The 2-in-1 market has exploded in popularity over the last couple of years, and we're now seeing the market awash with PCs that are as happy to operate as a touch-enabled tablet as they are a fully-fledged laptop with keyboard. In fact, we'd go so far as to say that the sheer number of tablets currently available is unsustainable, with consolidation of the segment inevitable in the next year or two, as the less successful brands fade away. That's not very helpful for prospective buyers looking to invest in a 2-in-1 right now, with a plethora of different models spread across a massive range of prices and form factors. We've rounded up ten of the latest models and run them through a gamut of tests to find out which ones deserve to call your backpack or handbag home.

HOW WE TESTED

As all of the 2-in-1s we tested use the Windows 8.1 Operating System, testing their performance couldn't have been simpler. PCMark 8's Home benchmark runs synthetic tests that replicate the demands of the average home user, broken down into key tasks that consumer PCs spend most of their time doing. The Web Browsing test measures how quickly the PC can open and load web pages, as well as the animation speed of items within the custom browser. Word Processing uses a custom word processor, used to run through the usual tasks associated with manipulating text documents, such as opening and saving files,

resizing documents, cutting and pasting text and inserting pictures. While none of these PCs can handle serious PC games, the casual gaming test fires up a simple 3D scene and measures how quickly the PC can render it, including several visual effects such as level of detail manipulation, diffuse and detail maps, and dynamic lighting. Most consumer PCs will spend some of their time editing images, which is why the PCMark 8 Home test includes a comprehensive image editing benchmark. This looks at the performance across standard image editing tasks, such as opening and closing files, resizing images and touching up image quality via brightness, contrast and saturation controls. The final benchmark measures video conferencing performance, testing how quickly the PC can render a 720p H.264 file.

Ice Storm was used to test basic gaming performance. This test is built for entry-level graphics performance, a perfect match for the relatively weak GPUs found in 2-in-1 laptops, and once again a higher score indicated better graphics performance.

The third and final test was PCMark 8's battery test, which runs the Home benchmark in a loop until the battery dies. This is a worst-case scenario for battery performance, which is why the results are often far lower than the battery life quoted by the manufacturer. Expect each PC to have substantially longer battery life in real world use, but the benchmark is useful for illustrating which PCs have superior battery capacity and energy efficiency.

When judging each 2-in-1, we combined the overall performance of each machine with its features, such as screen, touchpad and keyboard quality,

"We'd go so far as to say that the sheer number of tablets currently available is unsustainable."

We ran the Home benchmark in accelerated mode, which takes advantage of any hardware acceleration offered by the hardware within. The final score is a combination of the above tests into one score, where higher scores indicate better performance. Futuremark's 3DMark

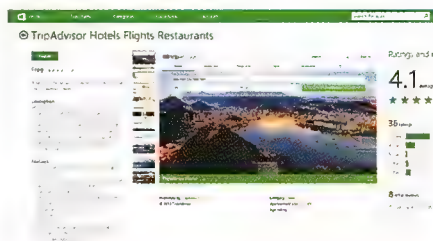
as well as the range of inputs and outputs. Finally price was thrown into the mix, and the end result delivers a holistic view of each machine.

1. PC BENCHMARK RESULTS				
	PRICE	3DMARK ICE STORM (DEFAULT VALUES, OVERALL SCORE)	PCMARK - HOME (ACCELERATED, OVERALL SCORE)	PCMARK BATTERY LIFE
ACER ASPIRE SWITCH 10	\$749	14,432	1,040	4:55HR
ASUS TRANSFORMER BOOK T100T	\$599	16,724	1,227	4:35HR
DELL INSPIRON 11 3000 SERIES	\$799	29,572	1,987	4:34HR
DELL INSPIRON 11 7000 SERIES	\$1,299	35,623	2,123	3:20HR
HP PAVILION X2 10-J008TU	\$499	DNF	1,228	8:59HR
MICROSOFT SURFACE PRO 3	\$1,549	40,130	2,230	2:53HR
LENOVO YOGA 3 PRO	\$2,099	30,869	1,786	4:10HR
PANASONIC TOUGHBOOK CF-C2	\$2,999	37,933	2,149	DNF
TOSHIBA SATELLITE P30W-B	\$1,599	34,908	2,089	3:24HR
TOSHIBA SATELLITE P50W-B	\$1,599	39,665	2,087	4:32HR

DNF = did not finish test

10 apps for Windows 2-in-1s

While Android has a more established market for touch-ready apps, finding great Windows apps for tablets and 2-in-1s is a bit more tricky. With many of the units we tested this month running Microsoft's OS, we've put together our picks for the best touchscreen-friendly Windows apps.



TripAdvisor

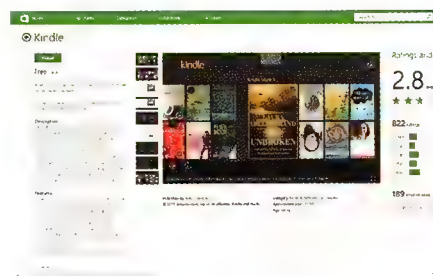
FREE
TINYURL.COM/APC410W8TRIP

Don't leave home on your next holiday without using the brilliant Trip Advisor app. Not only will this find the cheapest price for each hotel, scanning dozens of sites for the lowest cost, it also has comprehensive user reviews of every major hotel. Use this app and you'll never have to worry about waking up covered in bed bug bites again.

eBay

FREE
TINYURL.COM/APC410W8EBAY

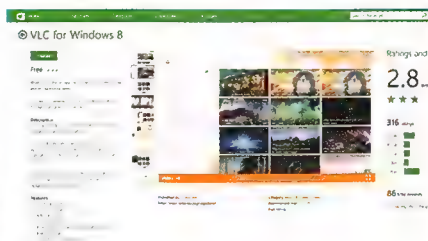
The official eBay app turns the finger-unfriendly web site into an experience that can be perfectly navigated with a tap of the screen. Gone are the dozens of tiny buttons and fields that require laser-like precision to activate, replaced by an interface that borrows heavily from the Windows 8.1 Start screen, with plenty of colourful tiles that are easy to use.



Kindle

FREE
TINYURL.COM/APC410W8KIND

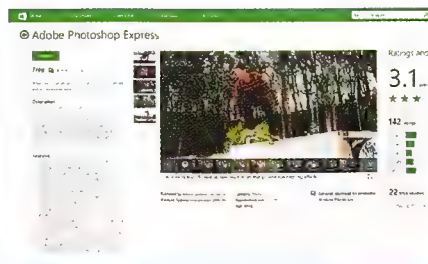
Tablets double as brilliant e-Readers, and Kindle is arguably the best way to obtain digital copies of your favourite novels. While the app itself is free, you'll have to pay to buy most books, but the prices are extremely competitive compared to print versions.



VLC for Windows 8

FREE
TINYURL.COM/APC410W8VLC

While Windows 8.1 includes the Windows Media Player, it doesn't support many of the advanced video codecs popular amongst downloaders. Enter VLC, a free media player that packs support for more obscure file types, such as .mkv. It's also got an excellent range of image and audio manipulation options, perfect for enhancing the quality of less-than-perfect videos. The default image quality of VLC is superior to Windows Media Player.



Adobe Photoshop Express

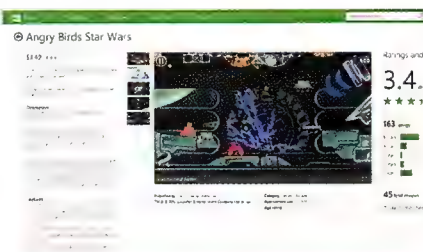
FREE WITH IAP
TINYURL.COM/APC410W8PSHOW

This cut-down version of Adobe's extremely popular Photoshop suite is perfect for basic photo editing on your tablet. The interface has been designed with touch in mind, and it delivers the basic functionality to touch up your happy snaps. These include automatic image correction, cut and crop, special effects filters and noise reduction.

Urbanspoon

FREE | TINYURL.COM/APC410W8URB

You'll never suffer from an average meal again after installing Urbanspoon. This review-based application shows user-submitted reviews of local restaurants, and it's very hard to fake a score. Perfect for finding your favourite new dining spot.



Angry Birds Star Wars

\$3.49
TINYURL.COM/APC410W8ABSW

There's a reason Angry Birds is incredibly popular on tablets, and it's because the gameplay mechanics are designed with touch controls in mind. This deceptively simple game requires the player to drag a slingshot back on screen, firing a bird into dozens of different *Star Wars* inspired levels, with the goal to destroy the pigs on screen. The cute 2D graphics style doesn't require a lot of horsepower to run, making this game perfect for less capable 2-in-1s.

LastPass

FREE
TINYURL.COM/APC410W8LAST

Tired of writing down dozens of passwords in your notebook, only to lose it or leave it at home when you need to access a certain site? LastPass is a secure password vault that digitally stores all of your account names and passwords. All you need to remember is the one password that unlocks the LastPass vault, and it can even generate super-complex passwords that hackers will find impossible to guess.

Skype

FREE
TINYURL.COM/APC410W8SKYPE

The original is still the best. Skype's video quality has improved leaps and bounds as Australia's broadband network has enabled faster upload speeds, and it's now possible to have a stream that almost looks like HD. The onscreen controls are nice and big, making this the perfect video conferencing app for your new 2-in-1.

Facebook

FREE | TINYURL.COM/APC410W8FACE

While it's possible to browse the full Facebook site on most tablets, the standalone app definitely offers a superior touch experience. On-screen controls are much bigger in the app, so social butterflies won't need the touch accuracy of a surgeon to sort through their friends list, send messages or set up events.



TABLET/LAPTOP HYBRID

#749 | WWW.ACER.COM.AU

Intel Atom Z3735F CPU; 2GB memory; 51GB flash drive.

Acer Aspire Switch 10

The world's first 4-in-1?

This mid-range convertible offers an excellent balance between mobility and functionality, in a very affordable package. Helping it to stand out are the four different display modes. There's the usual laptop and tablet modes, but the screen can also be displayed to a viewer opposite the operator, with the keyboard intact. The screen can also flip past 180 degrees, allowing the unit to stand in the form of the letter A, with the display on the exterior. As a result it's a flexible convertible for presenting information to other viewers.

The 10.1-inch display packs a super crisp 1,920 x 1,200 pixels, and is protected by the latest Gorilla Glass 3 material. Viewing angles are excellent, as is the image quality, thanks to the IPS display. The entire unit weighs 1.17kg, making it easy to lug around all day. The Intel Atom Z3735F processor is extremely power efficient, but it's also a

lightweight when it comes to performance, with the Switch 10 proving to be the slowest machine in our benchmarks. The range of input/output ports are also disappointing, with a single USB 3 connection alongside mini HDMI and mini FireWire ports, as is the onboard storage, with our sample displaying just 51GB of usable space. We love the portability and wide range of display options found on the Switch 10, but the lacklustre performance makes the high price tag hard to justify. On the flipside, the power-sipping hardware did deliver excellent battery life. Suited to those who need an ultraportable demonstration convertible who don't mind sacrificing speed for flexibility.

Verdict

A stunning screen and highly mobile, but extremely ordinary specs and features.



TABLET/LAPTOP HYBRID

#599 | WWW.ASUS.COM.AU

Intel Atom Z3740 CPU, 2GB memory, 49.1GB flash drive.

ASUS Transformer Book T100T

This convertible trades performance for price.

It's hard to believe that fully fledged Windows 8.1 PCs can be as small as the T100T. Despite having the same display size of 10.1 inches found on several other convertibles, the T100T feels even smaller than the rest. Weighing just 1.07kg with the keyboard in place, it's one of the lightest convertibles around.

This is likely a result of the relatively average hardware within. The IPS display has a resolution of just 1,366 x 768, which sounds lacking compared to the crisp HD of competing PCs but looks fine in operation. The hinge keeping this in place is extremely stiff, allowing full use of the touch screen while the keyboard is in place. Speaking of which, the chiclet keyboard is surprisingly roomy considering the tiny dimensions of the hardware.

Intel's Atom Z3740 processor drove our review sample, and it simply couldn't keep up with the

laptop processors found in larger convertibles. This is paired with a mere 2GB of memory, along with 49.1GB of usable storage space. I/O options are identical to the Switch 10, with a single USB 3.0 alongside mini HDMI and mini FireWire. In fact, the T100T shares much in common with the Switch 10, with both machines having extremely similar specs and features, and exceptional battery life. The Switch 10 has an ace up its sleeve in the form of the extremely accurate stylus, a killer feature that the T100T is lacking. As a result, for those looking for the ultimate in portability we'd suggest spending that little bit extra to get the T100T.

Verdict

The T100T shares much in common with the Acer Switch 10, but the latter includes an excellent stylus.





TABLET/LAPTOP HYBRID

\$799 | WWW.DELL.COM
Intel Core i3-4010U CPU, 4GB memory, 500GB mechanical HDD.

Dell Inspiron 11 3000 Series

A potent little 11.6-incher.

This is the first of the convertibles that increases the screen size to 11.6 inches. It doesn't sound like much on paper, but it makes the overall size considerably larger than the 10.1 inch models. Likewise with the weight, with the review unit tipping the scales at 1.49kg. While this makes it a little cumbersome for road warriors, the extra chassis size allows for considerably upgraded specs.

The 11.6 inch screen uses a relatively low resolution of 1,366 x 768, but still looks easy on the eye thanks to its tiny dimensions. Unlike many convertibles, it's not detachable, instead folding back over the rear of the keyboard to operate in tablet mode. Doing so disables the keyboard, to avoid unintended key strokes. The hinge design is reassuringly tight, stopping the screen from flexing when in laptop mode, and can handle the same unique poses as Acer's Switch 10. Intel's Core i3-4010U handles the heavy

lifting, without compromising on battery life, and it's paired with 4GB of memory. It ranked around the middle of the pack of our performance benchmarks, ensuring a slick, responsive experience. A healthy 500GB of mechanical storage provides plenty of room. We especially appreciated the excellent touch pad, a sore point on some of the other convertibles, while the keyboard is large enough to touch type. Three USB ports and a full-sized HDMI output sit alongside the card reader, providing plenty of options for connecting external devices. At \$799, it offers excellent performance in a size that's easy to carry. Our only complaint is the permanent fixture between the screen and keyboard.

Verdict

Dell has packed surprisingly potent hardware into this tidy form factor, we just wish tablet mode detached.



TABLET/LAPTOP HYBRID

\$1,299 | WWW.DELL.COM
Intel Core i5-4210U CPU, 8GB memory, 500GB mechanical HDD.

Dell Inspiron 11 7000 Series

Dell's Inspiron 3000 Series on steroids.

Take Dell's excellent Inspiron 11 3000 series and feed it steroids and you'll end up with the 7000 series. This 13 inch convertible is big enough to include the standard features found in most ultraportable laptops, with the added bonus of tablet functionality... to a certain extent.

The large screen comes with a native HD resolution of 1,920 x 1,080, perfect for a display of this size. Images are crisp and clear, but it's not so high that icons and font becomes unreadable. Once again Dell has opted for a hinge that doesn't allow the detachment of the screen; instead it folds behind the keyboard to operate in tablet mode. Those who want the convenience of a machine that can operate in pure tablet mode, removing the keyboard, might find this a turnoff. Running the touch screen in keyboard mode sees a little bit of flex when touching the screen, as the hinges aren't quite stiff enough to handle the larger

screen. This issue is by no means unique to Dell though. The included stylus is passive, which makes it tolerable if not perfect. Our benchmarks show it's one of the fastest convertibles in the roundup. This is undoubtedly a result of the relatively powerful i5-4210U CPU, which operates alongside 8GB of memory. It's no surprise that this hardware combination resulted in a lower battery life, sitting at 200 minutes. The same 500GB mechanical drive is installed as the 3000 series, but only 457GB of it is usable. While the specs are impressive, the jump in size and performance results in a hefty price rise. When measured against similar units, the lack of true tablet mode hurts our results.

Verdict

This pricey performer has pleasing specs, but the lack of true tablet mode holds it back.





TABLET/LAPTOP HYBRID

\$499 | WWW.HP.COM/AU

Intel Atom Z3745D processor, 2GB memory, 21.6GB usable flash storage.

HP Pavilion x2 10-J008TU

Worst. Stand. Ever.

We're not sure what HP's engineers were thinking when they designed the fabric, flexible stand that ships with this convertible. After figuring out how to use it, we were disappointed to note that it could only be used at certain angles; try to move the display to anything past 45 degrees and it would collapse every time. At least it won't fail over time, thanks to the hinge-free design.

The 10.1 inch display can be removed entirely from the base, and it uses a clever magnetic latch that won't suffer from wear and tear. With a unique resolution of 1,280 x 800, it remains crisp and clear due to the screen's smaller dimensions. The keyboard feels a little flimsy compared to other convertibles, with noticeable flex and a touchpad that often loses tracking. That's the price to pay for such an affordable machine.

At this price we didn't

expect stratospheric specs, and weren't surprised at what we found. Intel's super-efficient Atom Z3745D does the hard yards, alongside a meagre 2GB of memory. Long term storage is particularly lacking, with just 21.6GB of usable space. Thank the tech gods for cloud storage. Battery life was incredible though, outpacing every other tablet by a large margin.

While we appreciate this machine's extreme portability and all-day battery life, with the entire unit weighing just 857 grams, it's definitely underpowered for the price. ASUS' T100T is almost as affordable, yet offers more bang for your bucks.

Verdict

This ultraportable is light and cheap, but the average stand and lack of storage are deal breakers.



TABLET/LAPTOP HYBRID

\$1,549 | WWW.MICROSOFTSTORE.COM

Core i5-4300U, 8GB memory, 232GB of usable flash storage.

Microsoft Surface Pro 3

Rapid iteration delivers a killer convertible.

We feel for early adopters of the Microsoft Surface, as the company has been churning out new models at an alarming rate, making their initial purchase seem obsolete well before it should have. The good news is that the latest model clears up all of the concerns of earlier Surfaces, and ends up being one of our favourite convertibles.

Whether you like the ultra-thin keyboard is a matter of taste; there's no denying it'll take some getting used to. The benefit is that attaching the keyboard barely alters the size or weight of the entire unit, which weighs in at just 800 grams. The 12 inch display is one of the best in the biz, with a superb resolution of 2,160 x 1,440, and the entire unit is just 0.55 inches thick. Even better, it's extraordinarily accurate when used in conjunction with the included stylus, making this the preferred machine for

handwritten notes. The new stand allows for viewing at multiple angles, but it's the hardware within that propels the Surface Pro 3 to another league. Our review sample included the powerful Core i5-4300U CPU, along with a meaty 8GB of memory. The only area of concern is the onboard storage, with our high-end version still limited to just 232GB of usable flash storage. If there's one concern, it's that the speedy CPU chews through battery life. We have to admit that the Surface Pro 3 is one of our favourite convertibles, delivering scorching performance in a very portable design. There is a price though, with our sample carrying a hefty price tag of \$1,549. Youch.

Verdict

Highly portable, extremely powerful and with the best stylus around, shame about the price.



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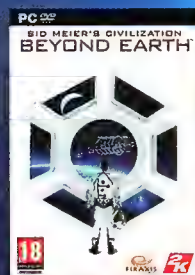
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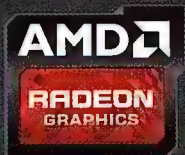


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TABLET/LAPTOP HYBRID

\$2,099 | WWW.LENOVO.COM

Intel Core M-5Y70 processor, 8GB memory, 221.9GB usable flash storage.

Lenovo Yoga 3 Pro

This 13.3-incher is deceptively light... and expensive.

Asking over two grand for a 13.3-inch convertible is a little cheeky, so Lenovo had better back up its price tag with some superb specs. Throw in the fact that the screen isn't detachable, and it seems that this 2-in-1 is facing an uphill battle. Thankfully it's chock full of the latest hardware, all in a form factor that's light for such a large display.

The Yoga 3 Pro sets new records for ridiculously high resolution displays, with the 13.3-inch screen packing an incredible 3,200 x 1,800 pixels. Clever scaling means Windows remains perfectly usable despite this high res. The hinge that attaches said screen permanently to the base has nine points of contact, making it highly unlikely to fail after extended use. It's also sturdy enough to endure excitable touch contact without the screen bouncing around. Despite the size, the entire unit is incredibly thin at just 12.88mm, and it tips the

scales at just 1.19kg, making it one of the lightest 13.3-inchers ever made.

Despite the ultraportable weight and size, Lenovo has stocked this convertible with impressive hardware. Intel's brand new Core M-5Y70 processor achieved excellent performance numbers in our benchmarks while also delivering excellent battery life, undoubtedly helped by the generous helping of 8GB of memory. Our only area of concern is the long term storage, with a flash drive offering 221.9GB of flash memory. There's no denying how powerful and portable this unit is, but there is one major issue — the price. This is very expensive, but that's the price to be paid for such cutting edge features.

Verdict

13.3 inchers don't get much more portable nor powerful than the Yoga 3 Pro... nor as expensive.



TABLET/LAPTOP HYBRID

\$2,999 | WWW.PANASONIC.COM.AU

Intel Core i5-4300U processor, 4GB memory, 449GB usable mechanical storage.

Panasonic Toughbook CF-C2

For those who need to mistreat their convertible.

The Toughbook CF-C2 is neither the most portable nor most affordable convertible around. However, if you need to subject your 2-in-1 device to rigours that would destroy less robust PCs, there's simply no other option.

There's a reason it's the fattest convertible in our roundup; the hardware is surrounded by a thick magnesium alloy chassis that can handle being dropped from 2 feet six inches without taking a scratch. It's no wonder that it's so heavy, with the entire unit weighing 1.8kg. Considering it's built around a relatively small 12.5 inch display, this makes it a bruiser in the weight department. Said display is a 1,366 x 768 screen, relatively low res for a machine of this price point. It's also permanently attached via a rugged triple-hinge design connection. The spill resistant keyboard will take a bit of getting used to, as the liquid proof coating requires

extra force. The good news is that the larger dimensions have allowed Panasonic to stock this with some powerful hardware, which explains the extremely fast performance measured in our benchmarks. At its core is the zippy Intel Core i5-4300U processor, but the 4GB of memory is surprisingly low. 449GB of mechanical storage is included, and it's housed within a special shock-resistant casing. The CF-C2 might be shock-proof, but that doesn't include the price tag. At \$2,999 this is easily the most expensive machine in our roundup. But if it can survive a beating that would destroy more affordable convertibles, the high price tag will pay for itself in no time at all.

Verdict

If you demand a convertible that will handle an utter beating, you've really only got one option.





TABLET/LAPTOP HYBRID

\$1,599 | WWW.MYTOSHIBA.COM.AU

Intel Core i5-4210U processor, 4GB memory, 107GB usable flash storage.

TABLET/LAPTOP HYBRID

\$1,599 | WWW.MYTOSHIBA.COM.AU

Intel Core i5-4210U processor, 8GB memory, 1TB mechanical storage.

Toshiba Satellite P30W-B

More laptop than tablet.

If you're leaning towards a convertible that sacrifices a little mobility in return for a more laptop-like experience, the P30W-B could be just what your IT guy ordered. It's one of the larger machines in our roundup, but the detachable screen makes the tablet mode almost as portable as other competitors.

We have to point out the premium feel of this machine, with a sleek mixture of aluminium and plastic delivering one of the sexier convertibles on these pages. This fact is balanced out by the price; you can afford to look this good when you cost \$1,600.

The screen is a 13.3-inch 1080p IPS display, and it's a beauty, with excellent image quality, brightness and wide viewing angles. It's attached to the base by a fairly sturdy hinge, though the screen does bounce a little when touched in laptop mode. Detaching the screen results in one of the larger

tablets in this roundup, but the tapered edges make it appear thinner than it really is. Tucked away inside the screen is the powerful Intel Core i5-4210U processor, along with 4GB of memory. Performance was excellent, with the P30W-B recording some of the best results in the roundup. Battery life wasn't quite as impressive though, clocking in at 200 minutes. This is a worst case scenario though — expect it to last around twice as long for basic desktop duties.

It might be rather pricey, but the P30W-B is the perfect convertible for those who want a larger laptop that can handle tablet tasks.

Verdict

This premium convertible exudes quality, from its aesthetics to its performance.



Toshiba Satellite P50W-B

The behemoth of convertibles.

This is an absolute bruiser of a convertible, with its dimensions dictated by the whopping 15.6-inch display. As such, it's probably better suited to those who only take their PC on the occasional foray into the wild, as the overall weight of 2.2kg will get tiring after a while, but the large screen makes it a wonderful machine for presentations.

Unlike the P30W-B, the screen on its bigger brother is permanently attached via twin hinges. Each rotates through 180 degrees to flip the display onto the rear, or in tent mode. Due to the large size of the screen, touching it in laptop mode sees it bouncing around like a trampoline. Thankfully the typing experience in laptop mode is hard to beat, as the full-sized keyboard doesn't take any getting used to.

The large size of the entire unit also allows for plenty of inputs and outputs, including HDMI out, triple

USB 3.0 ports and a card reader.

As our benchmarks attest, this is a speed demon of a laptop, thanks to the Core i5-4210U processor and 8GB of memory. It benched towards the top of the pack, yet battery life remained excellent, a pleasant surprise. An even nicer surprise was the 1TB mechanical drive, which didn't seem to hurt the system's performance at all.

Toshiba has delivered a very capable product in the P50W-B, with excellent performance, plenty of features and the biggest display in the roundup. Just be aware that all of this adds up to a less mobile product.

Verdict

This might be much larger than the rest, but its size allows for potent hardware and plenty of features.



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Image is everything

With a new set of graphics cards hitting the shelves, the top-end of the GPU market is all shook up. So where does the smart money go now?

The new Maxwell GPU is one of the most efficient graphics chips we've ever seen.

Nvidia has dropped its Maxwell bomb on the graphics card industry, and we're now all a bit excited about Titan Black-style performance filtering down into more affordable, cooler and quieter cards. But the green team isn't your only option, no matter how much Jen-Hsun Huang might want it to be. There is also the Texan side of the graphics divide.

AMD's offerings may not have the single GPU power of the latest Nvidia silicon, but the current healthy competition in the PC graphics market means we consumer types can pick up affordable cards with unprecedented

levels of gaming performance.

It's a great time to be a PC gamer, and not just because of the vast breadth of wildly different titles out there from both established AAA-farms and the indie/crowdfunded bods. The vast majority of PC people are still using 1080p screens — around a third according to Valve's Steam Hardware Survey — and even right down at the \$100 level you can find graphics cards capable of delivering an excellent gaming experience at that now-standard resolution. And, because they're purely bus-powered, cards like the GTX 750 Ti represent an excellent drop-in upgrade for practically any

basic PC out there with a spare PCIe slot, regardless of PSU.

But incremental performance upgrades and price drops are only one part of the story. The evolution of the graphics card is continuing apace, with both the discrete GPU manufacturers, and Intel as purveyor of integrated graphics, moving towards new APIs and introducing new open and proprietary technologies to push things forward.

And there are new spaces future GPUs need to exploit too, with the rise of the 4K resolution and, of course, the increasing resolutions of virtual reality devices such as the Rift.



AMD has done some smart things with its new Tonga GPU for the R9 285.

So what do the graphics cards of today offer, and what do we need to prepare for in the future?

The lifetime of your current graphics card is probably longer than your previous one and, if the product cycles of GPUs continue to lengthen as they have been, your next one will be even longer lived. It's a common trend across components, with the gap between generations growing – whether by accident or design. So, where we were once used to a yearly product cycle we're starting to get close to a three-year gap.

While that might not do such great things for the rabid tech-mongers desperate for the next new thing to get super-excited about, it's actually a positive boon for the PC platform as a whole. Once upon a time, you had to work damned hard to keep pace with the changes in what made a gaming-capable rig, and spend a pretty penny doing so too. Now a decent graphics card won't suddenly be rendered obsolete every time a new AAA title is released.

POWER EFFICIENCY

But that doesn't mean innovation has become a casualty of the GPU war. While the iterative release of new GPU architecture has slowed we are seeing refreshes of existing chips at lower price points and with lower power demands filtering through between generations.

Efficiency in particular has become almost as much of a target as increased

performance now, with so much effort being given over to driving up the performance per Watt of new GPUs or mid-generation refreshes.

The new Maxwell cards from Nvidia – stretching back to the excellent low-end GTX 750 Ti – have focused specifically on driving down power requirements, and their operating temperatures have dropped in sync with this increased efficiency.

It's a market-wide push, too. AMD's latest mid-range card, the R9 285, is essentially a refresh of the existing Tahiti-powered R9 280, but its main focus is on driving down both the cost and the power demands. AMD has admitted though that the new GPU sitting inside the R9 285 isn't the full

"We're seeing refreshes of existing chips at lower price points and lower power demands between generations."

implementation of the Tonga silicon, so we can also expect a higher-spec R9 285X at some point raising the stream processor count from 1,792 to 2,048.

We're also seeing new features being designed by both AMD and Nvidia to improve the performance or image quality of their respective graphics cards. AMD's Mantle API is still in its beta phase at the moment, with worryingly few titles really taking advantage of its close-to-the-metal nature. And the ones that do make the most of it display some troubling characteristics with the latest version of AMD's GCN architecture.

Performance with the Tonga-based

cards actually drops when you switch from Direct3D to Mantle. It's a bug that can be fixed with software updates, but it sounds like it might require developers to update their titles accordingly. Moving forward, an API is only going to succeed if it can be forwards-compatible and still function with new hardware releases without requiring devs to back-patch older games.

DIRECTX 12

That's something Microsoft seems very confident about with its upcoming DirectX 12 release. It's a superset of DirectX 11, so there should be enough common ground for existing software to work with hardware built to the DirectX 12 standard. As a necessarily slightly higher-level API than Mantle, that should be something Microsoft can manage more easily.

The two main benefits of DX12 are a reduced CPU overhead and increased scalability across multiple CPU cores. This again ties into the efficiency trend we're seeing on the hardware side. The new API will enable more effective management of the CPU as a whole. In an example at the Intel Developer Forum this year Intel and Microsoft demonstrated a Gigabyte BRIX machine running the asteroid demo previously shown at SIGGRAPH. It renders thousands of unique asteroids and can switch from a DirectX 11 rendering path to a DirectX 12 one to demonstrate the benefits brought by the new API.

One option is to boost the graphics performance, and it does this by apportioning more of the available power to the GPU while dropping the CPU demands. Boosting the graphics while dropping unnecessary processor

performance means higher frame rates are available within the same power envelope. Alternatively you can opt to cap the frame rate at an acceptable level and DX 12 will manage both CPU and GPU loads to prioritise graphics performance while significantly dropping overall power demands. This has the added benefit of soothing CPU cooling fans, too.

SMOKE AND MIRRORS

But improved hardware management isn't the only new feature we can expect to see with the arrival of DirectX 12. Microsoft is also working on some interesting new rendering

Whither the wanderer?

The future of the powerful desktop GPU looks rosy, but what about the wandering stars of the mobile graphics world?

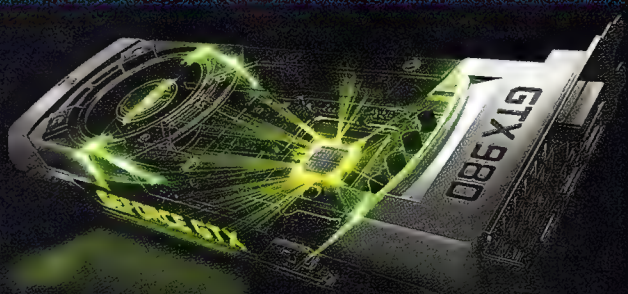
The plight of mobile PC gaming was at the forefront of Nvidia's launch of the GTX 980M and GTX 970M. The new mobile Maxwells were introduced alongside their desktop counterparts, but this time they have far more in common than just the names.

As power demands of desktop GPUs steadily increased, the performance gap between desktop graphics cards and the mobile iterations bearing the same name also increased. From the excesses of its power-hungry Fermi architecture Nvidia's Kepler GPUs have been trying to shorten that gap.

In the days of Fermi, the GTX 480M offered 40% of the performance of a straight GTX 480. With the GTX 980M, Nvidia is estimating the performance at about 80% of the GTX 980's.

Thanks in part, to the improved power efficiency of the Maxwell architecture, Nvidia is also making a push for proper mobile gaming. BatteryBoost is Nvidia's latest attempt to cut the power cord. With the 980M, switching to battery no longer kills the performance — the 100W available from the battery is enough to power the Maxwell GPU so you can keep gaming.

Then there's the problem of battery life. Taking the latest MSI



GT72 980M-powered laptop as an example, Nvidia had the machine's gaming life at just 49 minutes on a full charge. Using BatteryBoost pushes that up by 55% to 76 minutes. That's still not brilliant, but exceeds the one hour mark. On less intensive games though you could push over 100 minutes.

It's enabled by GeForce Experience, and drops the graphics settings on a game-by-game basis to leverage a little more playing time away from the plug socket, prioritising frame rate over top visual fidelity. Because it's in GFE though BatteryBoost too can be tweaked depending on your preference.

features for its next-gen API. Max McMullen, development lead for Direct3D 12, introduced a set of new techniques when Nvidia introduced its latest Maxwell GPU.

The first of these was rasteriser order views — something that sounds similar in design to the PixelSync DX 11 extension that Intel created last year. The idea is to aid the creation of transparent objects to allow for real time rendering that keeps the ordering of objects consistent — something that is currently incredibly difficult and costly to do. As well as helping to create realistic-looking transparent objects with multiple visible surfaces, this technology should make creating effective, interactive smoke effects possible too.

The next two rendering techniques, conservative rasterisation and volume tiled resources, are designed to help more accurately render both two- and three-dimensional shapes. Standard rasterisation operates on a small test point set in the middle of a pixel, determining whether a given pixel should be drawn or not. If the test point is touched by an object then it is drawn, if it misses the sample point it isn't. Sometimes this means that small objects, or parts of objects, don't hit any test points in one frame, but do in

another. This leads to these objects flicking in and out of existence in a scene. Conservative rasterisation solves this problem by using the whole pixel as a test point. This is now feasible thanks to the smaller pixels in modern displays, and means we get more consistent images without the blockiness you would experience with larger/fewer pixels in a scene.

LIFELIKE LIGHTING

Both that and volume tiled resources — a method of reducing the data size of a textured 3D scene — feed into Nvidia's latest attempt at bringing pseudo ray-tracing into real-time gaming. Voxel Global Illumination (VXGI) is its proprietary tech, soon to be introduced into Unreal Engine 4 and Crytek's CryEngine, is a method of calculating one-bounce lighting paths using voxels for more realistically lit scenes rendered in real time. Basically, it's accelerated on Maxwell GPUs

reducing the computational complexity of such expensive ray-tracing techniques.

But what about right now? There are graphics cards filling out pretty much every point on the price scale, but which ones make financial sense and which are just asking too much without giving anything in return? We've collected 12 of the best gaming GPUs around to answer that very question...





HIGH-END GRAPHICS

\$519 | WWW.NVIDIA.COM

Nvidia GeForce GTX 970

Great performance from Nvidia.

We haven't been this impressed with a new graphics card and GPU since the mini marvel that was the GTX 460. The top-end GTX 980 was impressive with its 2,048 CUDA cores and healthy video memory, but the GTX 970 is arguably better still.

Even cutting out 384 CUDA cores (in three full SMM units) barely touches the gaming performance of the GM204 GPU in the GTX 970. The fact Nvidia has kept the same memory configuration for this second tier Maxwell card is to its credit and, with something like this factory-overclocked Gigabyte GTX 970 G1 Gaming, the performance delta between it and the GTX 980 is minuscule. The combination of the super-efficient GM204 GPU and Gigabyte's Windforce cooling array makes it one of the coolest, most powerful \$500 cards ever. At this level you could easily ignore every graphics card above it up to

AMD's twin-GPU monster, the R9 295X2. The GTX 970 is cutting a swath through the high-end market. Because it's still got that hefty frame buffer, and the same compression algorithm magic as its big brother, it's every bit as capable a 4K gaming card as the R9 290X and GTX 980. The fact it can pretty much best a Titan Black is quite something too.

We've long held that top-end GPUs shouldn't really exceed the \$500 mark, and thanks to its efficiency and performance, there's almost no need to look higher up the stack. We're still looking for a chink in its armour, but for now the GTX 970 is getting a hot product award for being the ideal graphics card.

Verdict

A fantastic factory-overclocked card that justifies its price with serious gaming performance.



HIGH-END GRAPHICS

\$1,099 | WWW.AMD.COM

AMD Radeon R9 295X2

Beastly, but more power than value.

AMD didn't mess around when it was putting together its latest dual-GPU graphics card and that's what has made the R9 295X2 the very fastest card around. While Nvidia was getting all excited about its ridiculous \$3K Titan Z, AMD had liquid-chilled its top graphics processors and put the 295X2 out for around a third of the price. And smashed it for gaming performance too.

The manufacturer of every other dual-GPU card we've tested has had to down-clock the component graphics processors to get them onto the same PCB, sharing the same cooling array. Opting for a closed-loop liquid-cooler has allowed AMD to offer higher clockspeeds on the twin Hawaii XT GPUs than in its R9 290X. With a CrossFire total of 5,632 Radeon cores across the twin GPUs and a super-fast, high-capacity memory system, the R9 295X2 is without doubt your best bet for a single-card 4K

rig. The fact that you can hit 60fps in *Battlefield 4* at 4K Ultra settings should tell you all you need to know about the power of this thing. But it's not all about straight gaming performance with dual-GPU cards; there's also the trust issue. Really, if you have the space in your machine you're much better off going for a dual-card CrossFire/SLI array. Buying a dual-GPU card is like opting for RAID 0 rather than RAID 5; there's no redundancy. Not all games are coded to run with multi-GPU support either. If you're running at a standard 4K resolution though, that's not a huge issue; just one of its Hawaii XT GPUs, with its huge memory bandwidth, can pretty much keep pace with the best of Nvidia's.

Verdict

Certainly not a great-value card, but definitely an incredibly powerful one.





HIGH END GRAPHICS

FROM \$649 | WWW.NVIDIA.COM



HIGH END GRAPHICS

FROM \$779 | WWW.NVIDIA.COM



Nvidia GeForce GTX 780 Ti

The Titan killer is aging.

With the full fat GK110 GPU and the complete 15 SMX unit package, when new, this top-end consumer card took the crown from the ultra-enthusiast GTX Titan in one fell swoop.

With another 192 CUDA cores in that extra streaming microprocessor, 16 more texture units and a healthier clockspeed the GTX 780 Ti didn't need the full 6GB frame buffer of the Titan to give it the edge in gaming terms. Nvidia did bring in the Titan Black after the 780 Ti, but even that couldn't offer much more than the GK110. The GTX 780 Ti can still hold its head high in the face of stiff competition from the R9 290X and its direct replacement, the GTX 980. The new Maxwell-based card can push past the 780 Ti with fewer transistors, a smaller chip, lower power requirements and lower temperatures. But the last-gen GPU hasn't been utterly blown away in

performance terms. Still, even with the price cuts accompanying the GTX 780 Ti's slow march to the silicon graveyard, it's not a card we'd recommend you buy. Shopping around, you might be able to find one for as little as \$649. But considering the GTX 970 in overclocked trim is at least its performance equal and costs less, those price cuts aren't enough. Well, not unless you have an SLI-capable motherboard and a 780 Ti that is looking for a friend anyway. The GTX 780 Ti is still a capable graphics card, but now really only highlights how impressive the new GM204 GPU really is — going toe-to-toe with last generation's top-end, high-complexity GPU and beating it all counts.

Verdict

Still a capable graphics card, but the new 900-series cards have knocked it clean out.



Nvidia GeForce GTX 980

A performer that's light on power.

We've anticipated Nvidia's Maxwell architecture finding its way into the high end of its graphics card range since we first clapped eyes on the GTX 750 Ti in all its energy-efficient glory. Finally it's here and the new GM204 GPU is definitely worth the wait.

The new SMM layout can squeeze masses of cores into a small space and get more out of them than the previous Kepler designs. Nvidia has also done impressive things with the memory architecture, allowing it to use a relatively low-end 256-bit memory bus without affecting high-res performance. Its compression algorithms make the 7Gbps frame buffer perform far better than we expected. The GM204's performance per watt is unprecedented in gaming graphics cards. Normally that would have us worried about compromised performance at the top end, but the GTX 980 outclasses

the GTX Titan Black in our gaming benchmarks. That all makes the GTX 980 a very powerful graphics card, and one that doesn't demand its own power plant to keep you gaming. The GM204 is also highly overclockable and we were able to hit a stable 1.5GHz high. That boosted clockspeed makes a difference to your gaming performance too; push the clocks up and you will get a tangibly higher frame rate. But it is a pricey beast. Anything over \$750 for a graphics card still seems crazy to us, especially as this 28nm chip is going to be enjoying healthy yields and is unlikely to be costing Nvidia a fortune to make. If it wasn't for its little brother though, this card would be getting the win.

Verdict

Maxwell is impressive, and the GTX 980 has some killer features to back up its performance.





HIGH END GRAPHICS

\$1,299 | WWW.NVIDIA.COM

Nvidia GeForce GTX Titan Black

An oldie, but not a goodie.

When the first GTX Titan arrived, its only competition was the dual-GPU GTX 690. It didn't quite hit the same performance heights, but was barely shy in gaming terms — and all with a single graphics processor. Nothing else could match the meaty GK110's top-end performance.

And then Nvidia rumbled on, releasing more and more cards based on the stonking GK110 GPU. The GTX 780 followed with a cut-down version, then the GTX 780 Ti upped Nvidia's game with the full might of a 2,880-core GK110. With the Ti now outshining the GTX Titan, it released this Black version with full double precision performance and double the frame buffer. But with the performance of the GTX 780 Ti now available for half the price, the latest Titan feels rather unnecessary. The first Titan had double precision power for the pros and the gaming performance consumers loved. The Titan

Black only has some small relevance to the professional user, desperate for double precision processing without the price of the Quadro cards. Gamers picking up a Titan Black will be disappointed. At this price you might hope it could at least keep the R9 295X2 honest, but even though it's got a high-capacity, high-performance frame buffer the GK110 can't hope to pin back a pair of Hawaii XT GPUs. The Titan Black now lags behind the new GTX 980 too, so things aren't looking great unless you must have double precision. In its first flush the GTX Titan could make a case for itself. But now the GPU gang has caught up, this high-powered card has lost its shine.

Verdict

The Titan Black looked a little out of touch coming after the GTX 780 Ti, and is now looking geriatric.



HIGH END GRAPHICS

\$629 | WWW.AMD.COM



AMD Radeon R9 290X

AMD gets hot and heavy.

The R9 290X was an incredibly advanced card when it first arrived in our labs, but keeping 2,816 streaming processors running at a full 1GHz clockspeed came at a cost. There's a reason the R9 295X2 has to be water-cooled: these chips generate a their own personal Hades.

The reference design ran at a ridiculous 93°C at full pelt. AMD claimed it was rated to run at that temperature for its entire life, but we had a feeling that life might be pretty short with heavy use. Thankfully AMD partner Sapphire has come to the rescue on our test card with this Tri-X design, a relatively inexpensive third-party cooling solution attached to a modestly overclocked GPU. Suddenly Sapphire's R9 290X was running at a more sensible 71°C maximum and now we've got a thoroughly impressive high-end graphics card. Now the GTX 980 has arrived it's looking like last-gen tech when

you're talking about 1080p and 1600p gaming, but the R9 290X was one of the first cards to actually make 4K gaming a realistic goal. Even now, thanks to that 4GB frame buffer and 512-bit memory bus, it's able to stand toe-to-toe with the GTX 980 at 3,840 x 2,160. We'd still put our money on the Maxwell boards, but it must be reassuring for any AMD fanfolk out there to know they're top GPU hasn't been totally outclassed in terms of gaming performance. With the bottom also falling out of the GPU mining market, there are likely to be some AMD bargains floating around too. The R9 290X is still a power-hungry GPU, but if you can find it for a good price it's still got some legs.

Verdict

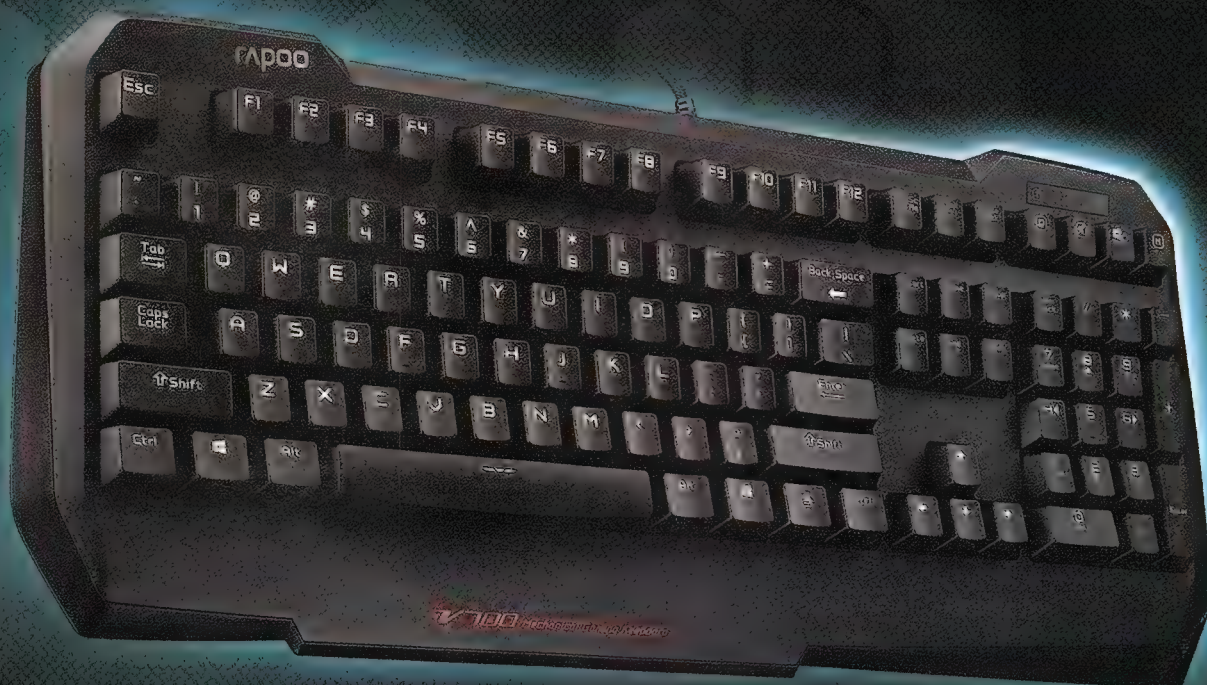
A quality high-res card, and Sapphire's cooling keeps the Hawaii GPU in check.





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V800
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Gaming Keyboard



V500
Mechanical Gaming
Keyboard

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AMD Radeon R9 290

Keep it cool to get the best results.

Back in the autumn of 2013, AMD released its Hawaii GPU based cards. The 290X dropped with the largest, most complex GPU AMD had ever made. It was followed by the suffix-less 290, which offered almost equal performance for far less cash.

Both these cards need some serious cooling to get the best out of them. The stock cooler, like the one on this reference-design R9 290, will end up with the GPU running at a painfully hot 93°C when under 100% load in-game. AMD though reckons that shouldn't be a problem for the life of your graphics processor. While we haven't seen any hard evidence to point to the contrary, having the fans spinning up as loudly as they do, and having that much excess heat floating around your expensive gaming rig, surely isn't going to make for the most pleasant gaming experience. Performance-wise though, the R9 290 is still a relatively happy

high-end card, now dropping perilously close to mid-range money. As we've already said, it's not far off the performance of the R9 290X, and will deliver decent high-res gaming frame rates. It's a little way behind an overclocked GTX 970, and is likely to trade blows with a reference clocked version. Therein lies the rub for this last of the high-end GPUs – the GTX 970 in any guise is causing problems with its heady mix of high performance, low power and chilled temperatures. If you can find an R9 290 with a third party cooler for this price it might be worth a punt for the AMD faithful, but we couldn't recommend anyone pick up either 290 or 290X with the struggling reference cooler.

Verdict

The reference cooler is a dog, but the second-tier Hawaii GPU is still a capable gaming graphics processor.



AMD Radeon R9 280X

This HIS is starting to show its age.

The AMD GPU powering this mid-ranger is over two years old; we got our first taste of its graphics architecture way back at the end of 2011. That's indicative of the slowing pace of GPU progress over the last few years, but also testament to the power of AMD's Graphics Core Next design.

In its first flush of youth the R9 280X was called the Radeon HD 7970, rocking the very first Tahiti XT GPU. Really though, the 280X is more like the higher-clocked GHz Edition of that card, as its boost clock sits around 1,000MHz. It was the daddy of the GPU world and its high-end heritage is still evident in the 2,048 streaming processors, the hefty 384-bit memory bus and the 3GB frame buffer. The chunky HIS cooler on our test card might have a fair bit to do with that as well, it runs nicely cool and impressively quiet too. The fact this ageing GPU is still capable of pumping out

decent 1600p gaming frame rates at the top settings makes this well-priced card a tantalising prospect. But the age of the silicon at its heart means you are missing out on some of the AMD advances. The 280X needs a physical bridge for CrossFireX support, and lacks both True Audio and the advanced GPU boost tech that came with the Hawaii and Bonaire chips and full support for FreeSync when DisplayPort 1.2a arrives. AMD has already replaced the R9 280 with the R9 285. Given the fully-featured Tonga GPU is able to hold the same 2,048 cores as the 280X, we wouldn't be surprised to see a top-spec R9 285X soon. That would have us holding off on the ol' 280X

Verdict

The R9 280X is showing its age, falling behind cheaper, slower, younger AMD models.





MID RANGE GRAPHICS

\$290 | WWW.AMD.COM



LOW END GRAPHICS

FROM \$225 | WWW.AMD.COM

AMD Radeon R9 285

AMD has nailed the mid-range.

When we first heard about the Tonga Pro-powered R9 285 from AMD, we were sceptical about whether it was really a new GPU, or another exercise in AMD rebadging. But no, the Tonga GPU is a fresh slice of GCN silicon, commonly known outside of AMD as GCN 1.2.

Our concern with the new R9 285 was that it seemed to be replacing a more advanced card. The old R9 280 had the same GPU configuration (1,792 cores, 112 texture units and 32 ROPs) as this new R9 285, with a seemingly superior memory setup. Because it shared a similar high-end heritage to the 280X, being built from the ruins of the HD 7950, it again had a 384-bit memory bus and a full 3GB of VRAM. That should mean the R9 285 will have a much lower memory bandwidth than the card it's replacing, so the high-res future will look a lot less rosy with the Tonga GPU. But AMD has, unsurprisingly,

outsmarted us. The Tonga architecture contains some funky lossless memory compression techniques that allow the effective memory bandwidth to belie that seemingly low 256-bit bus. With a higher clockspeed and the GCN 1.1 improved boost tech, the R9 285 is close to the performance of the 280X despite lacking the cores and memory configuration. And because it represents the latest implementation of the GCN architecture you get support for its full feature set. We're still sceptical as to whether 2GB is enough video memory. With the new consoles being more memory-heavy, future cross-platform games could suffer. But right now, the R9 285 has got the gaming performance.

Verdict

A great-value mid-range graphics card, nailing the sub-\$300 GPU market with aplomb.



AMD Radeon R9 270X

Squeezed into a difficult niche.

As soon as you drop to the ~\$200 mark things get mighty tight. That's because gaming speed seems to scale in a pretty linear way, meaning the cards crowded into this segment each fit into fairly price-sensitive niches.

With a card like the R9 270X then we end up having to say, if you've literally only got a hard and fast budget of \$225 to spend, then this is the one to go for. The issue here is that the release of new higher-end cards has compressed the lower echelons of the graphics card market, meaning that there's barely \$20 difference between one card and its empirically superior competition. With the R9 270X that's the GTX 760 just above it, but then you're looking ever upwards where another \$70 will get you into the world where the R9 285 is king. The Curacao XT GPU in the 270X was already on a hiding to nothing compared with the latest AMD card given that it's got much fewer

cores, but then you're also in the same boat as the old R9 280, missing interesting new features that make the latest iteration of GCN much more tempting. Things are just too tight then for the R9 270X to be able to justify itself to consumers. Sure, it's cheaper than the competition, but not by enough to make you forget the weaker gaming performance or the lack of the latest features. So, if you've literally only got a hard budget of \$225 to spend on a new graphics card, then this is the one to go for. But in real terms saving that \$70 over a far superior GPU becomes a false economy, forcing you into a position where you'll want to upgrade again all the sooner.

Verdict

The market is too tight to justify paying for weaker cards in the face of better ones.





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apc
RECOMMENDS

LOW END GRAPHICS

FROM \$170 | WWW.NVIDIA.COM

Nvidia GeForce GTX 750 Ti

Proves you can game on a budget.

We still have a soft spot for this quality little card. There are many reasons why this vanguard of the Maxwell GPU architecture pleases us so much and the price isn't even the main one.

It was a change of pace for Nvidia to release its new GPU architecture on a low-end card first. Things were different this time around, possibly because Nvidia was hoping for the 20nm production process to have its issues ironed out to allow for the subsequent GM204 to be manufactured on the small lithography. The GTX 750 Ti introduced us to the tech that has made the GTX 970 our favourite graphics card right now. The extra logic dropped into the new SMM units and extra parallel performance that squeezes more performance from the same number of CUDA cores, means that even though the GM107 comes with a paltry 640 cores, it can still give a decent account of itself. It's a

resolutely 1080p card, but you can get decent frame rates at the highest settings. Drop your demands a little and you'll get smooth gaming on the latest titles with this power-sipping card. And this efficiency makes us love the GTX 750 Ti even more. The reference model needs no extra PCIe power connectors, taking all its juice from the bus. And the GPU runs so cool it's a doddle to run it completely passively cooled – perfect for a silent living room PC plugged into your 1080p HD TV. The lack of power connectors means that almost any recent PC can accommodate a GTX 750 Ti. It really is the great leveller, making PC gaming practically possible for almost everyone.

Verdict

A fantastic low-end GPU. Cool, quiet and easily installed into any basic PC with a spare PCIe slot.



LOW END GRAPHICS

FROM \$240 | WWW.NVIDIA.COM

Nvidia GeForce GTX 760

Much like its AMD price equivalent.

There is a pitched battle going on between the new R9 285 from AMD and Nvidia's old GTX 760. The 285 has youth on its side, plus performance and memory compression techniques to put the lie to its 256-bit memory bus, leaving Nvidia to fight on price alone.

Is that enough? It's not a sustainable model, but it can't be long until the mighty Maxwell architecture seeps into the mid-range market. The GTX 760 then is left twisting in the wind, hoping that a slight saving and support for the likes of GeForce Experience might give it a helping hand. It's a long way behind the next Nvidia GPU still being made, though. After the launch of the GTX 980 and 970, everything from the GTX 780 Ti to the GTX 770 were discontinued. You can still find stock around, but that's the last of it. The 760 is a capable enough Kepler card at 1080p settings, but given the price proximity of the R9

285 it's impossible to recommend anyone purchase new. It's not a million miles behind the competition, but the main thing the R9 285 has going for it is that it often has much higher minimum frame rates. At this level of the market, a smoother gaming experience is most definitely worth the extra \$60 for the superior card. The GTX 760 really suffers by comparison, and seems to be Nvidia's sacrificial soldier, left to slow the enemy advance while it gathers some Maxwell-powered reinforcements to try and turn the tide against AMD's lower mid-range dominance. This Kepler card feels like it's had its day and should soon shuffle off to the GPU memorial home.

Verdict

An aging graphics card, struggling to justify itself against more vital competition from AMD's R9 285.





TECHlife

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How we tested

We take the guess work out of choosing the right graphics card.

Testing graphics cards can be a long-winded process, but it's not all just about a single average frames per second number any more. There are many things to take into consideration when you're picking through the vast array of graphics cards available these days.

Of course gaming performance is still the key metric, not to mention how the different cards can scale across different resolutions too. We've covered three levels of resolutions, all tested at the relevant game's highest graphics settings, with 4x MSAA attached. The first is the big 4K daddy. Running at the super-detailed 3,840 x 2,160 your GPU needs a lot of horsepower, and we're seeing cards with the necessary performance start to arrive.

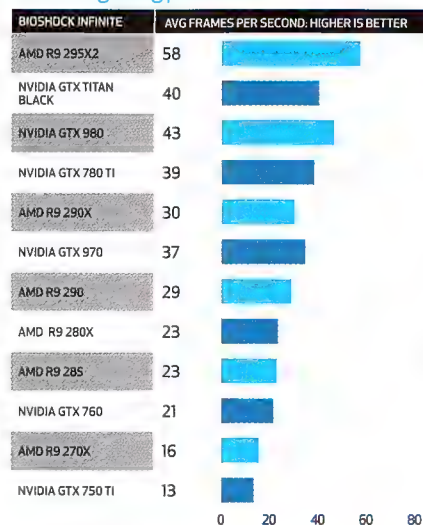
We also test at our standard 2,560 x 1600 and the prevalent 1920 x 1080 resolution. We've offered more testing at the last res as it's the most popular. In terms of the actual figures it's just as important to show the minimum frame rates achieved as it is indicative of either a smooth or choppy experience in-game.

Finally we've also tested the thermal performance of the different cards and how efficient they are in terms of power. Our performance per watt index is simply the 1080p average FPS score divided by the peak platform power draw in BF4 and times by 1,000 to deliver a more pleasing comparative index score.

LABS BENCHMARK RESULTS

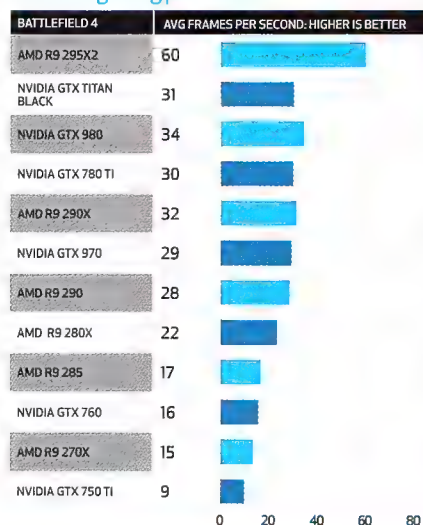
3,840 x 2,160 Ultra

DirectX 11 gaming performance



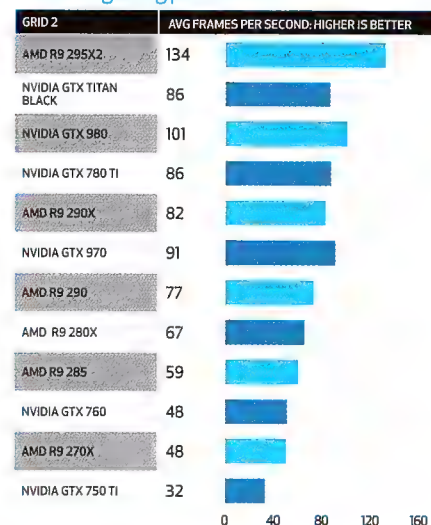
3,840 x 2,160 Ultra

DirectX 11 gaming performance



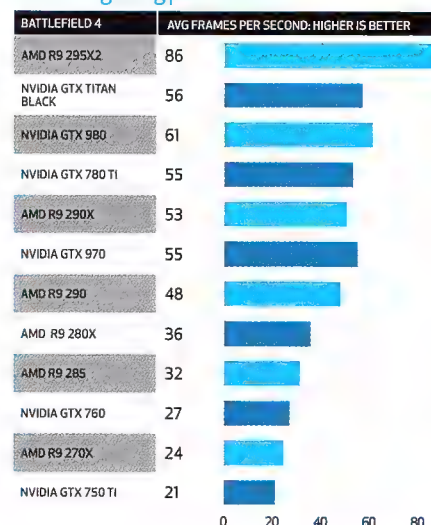
2,560 x 1,600 Ultra

DirectX 11 gaming performance



2,560 x 1,600 Ultra

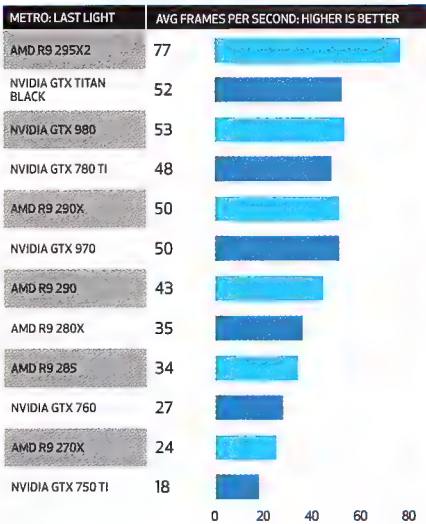
DirectX 11 gaming performance



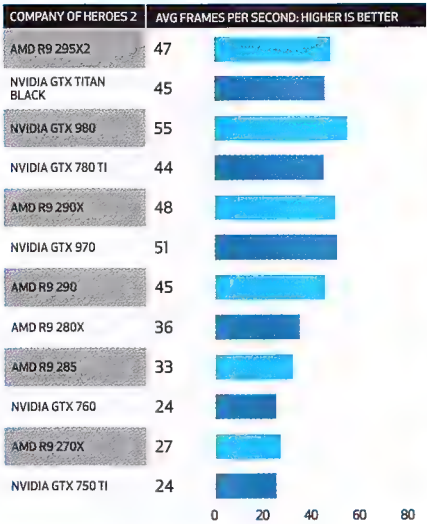
CRITICAL SPECS

	AMD RADEON R9 295X2	NVIDIA GEFORCE GTX TITAN BLACK	NVIDIA GEFORCE GTX 980	NVIDIA GEFORCE GTX 780 TI	AMD RADEON R9 290X	NVIDIA GEFORCE GTX 970
GPU	2X AMD HAWAII XT	NVIDIA GK110	NVIDIA GM204	NVIDIA GK110	AMD HAWAII XT	NVIDIA GM204
SHADERS	2X 2,816	2,880	2,048	2,880	2,816	1,664
TEXTURE UNITS	2X 176	240	128	240	176	104
ROPS	2X 64	48	64	48	64	64
MEMORY	2X 4GB GDDR5	6GB GDDR5	4GB GDDR5	3GB GDDR5	4GB GDDR5	4GB GDDR5
MEMORY BUS	2X 512-BIT	384-BIT	256-BIT	384-BIT	512-BIT	256-BIT
CORE CLOCK	1,018MHZ	889MHZ	1,126MHZ	875MHZ	1,010MHZ	1,178MHZ
TDP	500W	250W	165W	250W	290W	145W

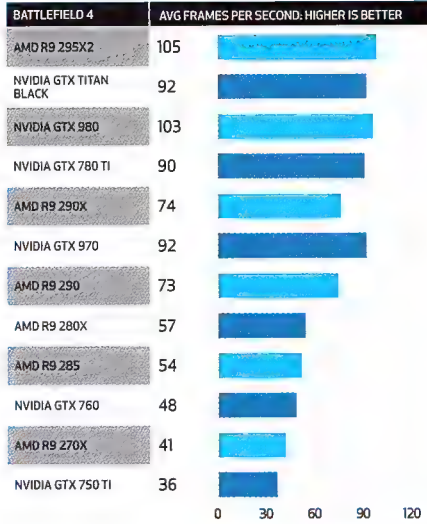
1,920 x 1,080 Ultra
DirectX 11 gaming performance



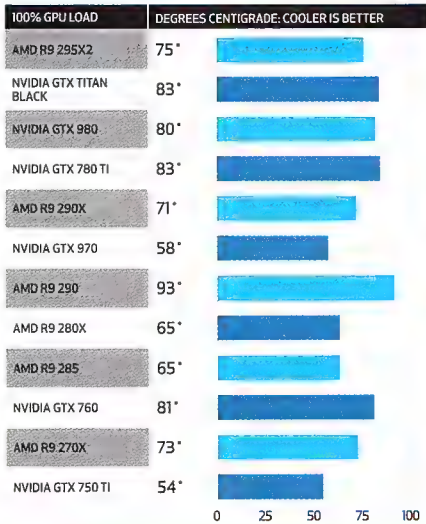
1,920 x 1,080 Ultra
DirectX 11 gaming performance



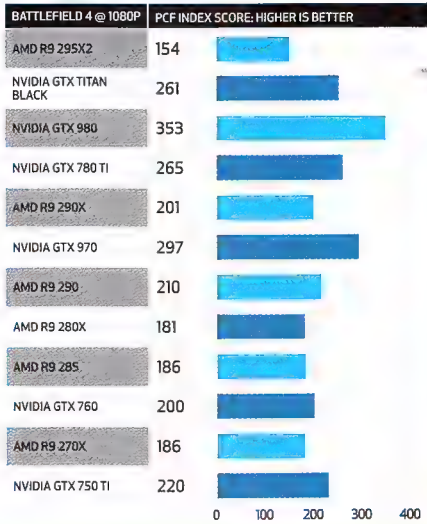
1,920 x 1,080 Ultra
DirectX 11 gaming performance



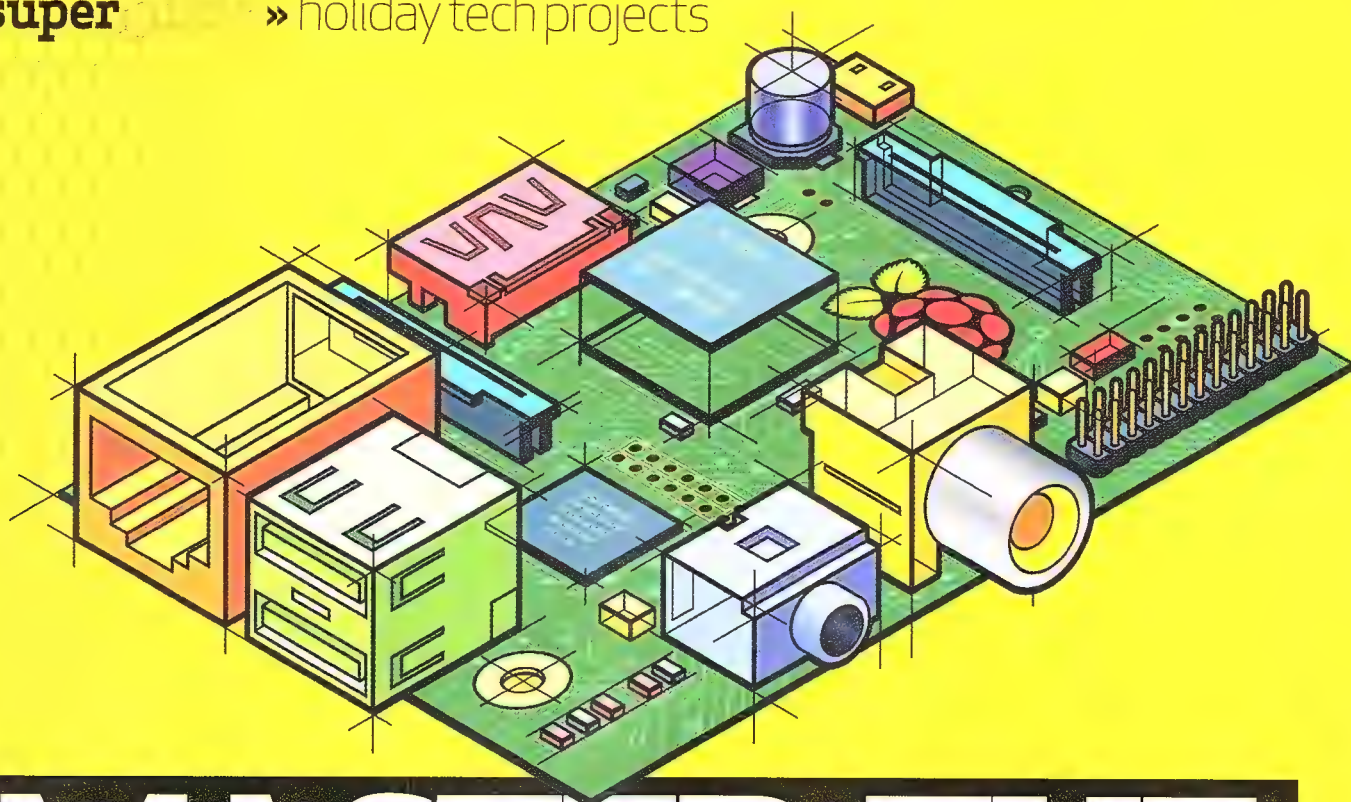
Thermal performance



Gaming performance per watt



AMD RADEON R9 290	AMD RADEON R9 280X	AMD RADEON R9 285	NVIDIA GEFORCE GTX 760	AMD RADEON R9 270X	NVIDIA GEFORCE GTX 750 TI	
AMD HAWAII PRO	AMD TAHITI XTL	AMD TONGA PRO	NVIDIA GK104	AMD CURACAO XT	NVIDIA GM107	GPU
2,560	2,048	1,792	1,152	1,280	640	SHADERS
160	128	112	96	80	40	TEXTURE UNITS
64	32	32	32	32	16	ROPS
4GB GDDR5	3GB GDDR5	2GB GDDR5	2GB GDDR5	2GB GDDR5	2GB GDDR5	MEMORY
512-BIT	384-BIT	256-BIT	256-BIT	256-BIT	128-BIT	MEMORY BUS
947MHZ	850MHZ	965MHZ	980MHZ	1,000MHZ	1,020MHZ	CORE CLOCK
275W	250W	190W	170W	180W	60W	TDP



MASTER THE RASPBERRY PI

Follow in the footsteps of free software wizards as Mayank Sharma shows you how to master the Raspberry Pi by hacking it.

The Raspberry Pi was conceptualised as an educational device. The Raspberry Pi Foundation designed the no-frills computer to make an affordable and functional computing device for kids who wanted to learn to program, but found it difficult to come up with the cash to procure hardware off-the-shelf. However, the device hit it off with the hackers and modders who began using it creatively and made it usable to audiences far beyond what Eben Upton, Rob Mullins, Jack Lang and Alan Mycroft had originally imagined when discussing the idea at the University of Cambridge's Computer Laboratory.

But this has created a misconception. A lot of people believe that the Pi can either be used inside an elementary educational institute or in the hands of an experienced campaigner who'll plug

it inside a RC car or space-faring teddy bears. While this is true, the Pi is also an excellent tool to cover the ground in between these two extremes.

Now don't sound surprised when we tell you that hacking with the Pi is a nice way to learn about Linux and programming. And we aren't the only ones to say this. Raspberry Pis are fast finding thier way onto school computing curriculums.

They're being used to teach kids between 5 and 7 years how to write and test simple programs on different devices, such as a tablet or the Raspberry Pi. Then there's more advanced concepts where kids between ages 7 and 11 are introduced to Scratch which is installed by default on the official Pi distro Raspbian. After that, kids between years 11 and 14 are introduced to text-based languages like Python to control electronics. The Pi is a wonderful platform for this

application because of its accessible GPIO ports on which you can hook up devices, such as Pibrella. Finally, the older kids aged between 14 and 16 can make use of the excellent add-on kits available for the Pi to develop their computation abilities.

In this feature we'll help you pick up new skills as you hack with the Raspberry Pi. Just make sure you have one ready. Use NOOBS to prepare an SD card for the Pi. Download it, from www.raspberrypi.org/introducing-noobs/ unzip it and copy the extracted contents onto a formatted SD card, and you're up and running.

This feature covers some very practical everyday projects that can be rolled out by anyone, irrespective of their skill level. As you complete each of these 10 hacks you'll learn some tricks of the trade that are widely used today....

Skills: Security, Twitter API

HACK #1: TWEETING CAMERA

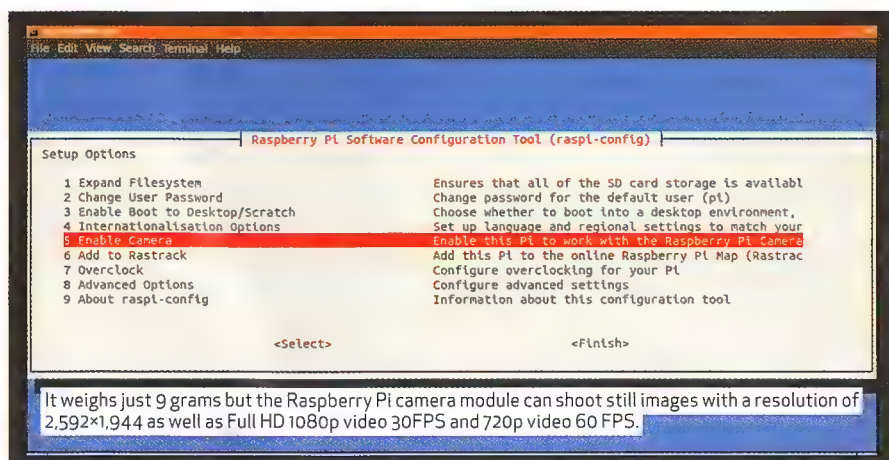
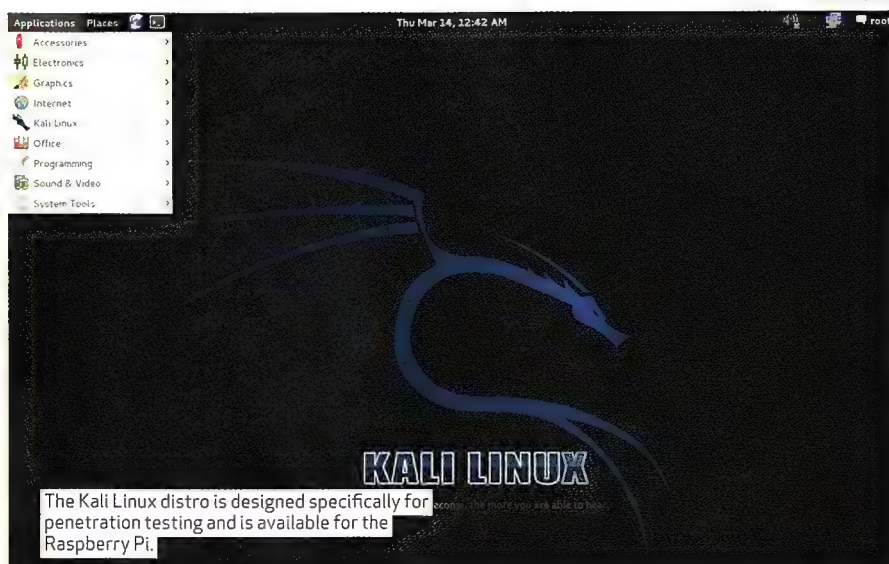
The launch of the official Raspberry Pi camera module threw open a world of possibilities. Hackers who were already using USB cameras now had a minuscule Full HD shooter, ideal for projects like surveillance. Combined with the Pi's computing prowess, you can send the captured security images into your Twitter stream.

Before you attach the camera, locate the Camera Serial Interface (next to the Ethernet port) and pull the tab gently up. Now push the camera module's ribbon cable into the slot, with the silver contacts on the cable facing away from the Ethernet port. Remember not to push the cable in very deep. Hold it in place with one hand and push the CSI tab back down with the other.

With the hardware in place, it's now time to set up the software. Boot into Raspbian and bring up the configuration tool with `sudo raspi-config`. Scroll down the list to Enable Camera. You'll need to confirm your choice and restart your Pi. On restart, you'll be able to use the `raspistill` and `raspidvid` commands to capture still images and videos respectively.

To capture motion, we'll use the lightweight motion detection Python script. The script relies on the Python Imaging Library which is a library for analysing and manipulating images. You can install it with `sudo apt-get install python-imaging-tk`. Also create a directory named `picam` under your home directory for the script to store images with `mkdir ~/picam`. Now grab the script and make it executable with `wget -c http://pastebin.com/raw.php?i=yH7JHz9w -O picam.py` and make it executable with `chmod +x picam.py`.

When you run the script with `./picam.py`, it'll turn on the red LED on the Pi camera and start taking low-res images. It'll then look for movement by comparing the pixels in two consecutive images. If it detects changes, the script will capture a higher-resolution image. The script is very efficient and will automatically remove the low-res images it captures for comparison.



To run the script at boot, you'll need an init script that runs the `picam.py` script and kills it before shutting down the Raspberry Pi. Grab the script with `wget http://pastebin.com/raw.php?i=AfqbJQrb -O picam_init` and move it into the correct location with `sudo mv ~/picam_init /etc/init.d/picam` before making it executable with `sudo chmod +x /etc/init.d/picam`. Finally, make the boot system aware of this script with `sudo update-rc.d picam defaults...`

The script will now start and shutdown along with the Raspberry Pi. You can also manually control it like any other daemon. For example `/etc/init.d/picam stop` will stop the script and `/etc/init.d/picam start` will start it.

POST TO TWITTER

We'll now setup a new Twitter account and ask the Pi to post images to it. Make sure the account is private. Install Python's pip package manager for installing Python libraries with `sudo apt-get install python-pip`. Then install Twython: a Python wrapper for the Twitter API with `sudo pip install twython`. Note: To use Twython you need a Twitter developer

account. Head to apps.twitter.com and sign in with the credentials of the new account. Click on 'Create New App' and use the space provided to give it a name and a description. Leave out the Callback URL field, scroll down the page and create the app.

Initially, the app is created with read-only permissions. Click on the app, switch to the Permissions tab and toggle the Read and Write radio button. Then switch to the API Keys tab and click on Create My Access Token button. Make a note of the API Key, API Secret, Access Token, and Access Token Secret.

Then download the modified `picam` script, altered to post captured images to Twitter with: `https://raw.githubusercontent.com/ghalfacree/bash-scripts/master/picamera-security.py` > `picam.py`

Open this new `picam.py` in a text editor and insert the four bits of information you jotted from Twitter in the space provided at the top.

When done, make it executable with `chmod +x picam.py`. Now when you run the script and it detects motion, in addition to capturing an and storing an image, the Pi will also post it on your private Twitter account which will then show up in your Twitter feed.

Skills: Networking, interoperability, data management

HACK #2: FILE-SHARING SAMBA SERVER

The ability to share and access data on your Raspberry Pi from other machines is very useful indeed. For example, if you are using it as an always-on download box, you'd want to move the downloaded data off the Pi as well. Now that data could either be on the SD card or on an attached USB disk. With the Samba software – which is an implementation of the SMB/CIFS networking protocol – you can use your Raspberry Pi as Network Attached Storage (NAS) device and easily access the USB drive attached to the Pi from computers on your network.

The `sudo apt-get install samba samba-common-bin` command will fetch the required software. Now, attach the USB disk to the Pi which will be automatically mounted under the `/media` folder. Let's assume the USB drive is mounted to `/media/usb`. You now need to configure Samba so the drive can be shared on the network. To do this, you first need to add a Samba user called pi. Enter the `sudo smbpasswd -a pi` command and type

in a password when prompted. Next, open Samba's configuration file (`/etc/samba/smb.conf`) in a text editor. If you wish to access the Pi from a Windows machine, locate the `workgroup = WORKGROUP` line near the top of the `smb.conf` file and change it to the name of your Windows workgroup. Further down, locate the `# security = user` line and remove the `#` to uncomment the line and turn security on.

Lastly, scroll down to the end of the file and add the following lines:

```
[USB]
path = /media/usb
comment = USB NAS Drive
valid users = pi
writeable = yes
browseable = yes
create mask = 0777
public = yes
```

Save the file and then restart Samba with `sudo /etc/init.d/samba restart`.

You'll now be able to access the USB drive attached to the Pi from any other computer on the network.

HACK #3: RASPBERRY PI AS A THIN CLIENT

A thin client is a computer that depends on other powerful computers to do the heavy lifting. Thanks to its power efficient and noiseless design, the Raspberry Pi is a natural thin client.

For this hack, you'll need a powerful computer that'll act as the remote server and the Raspberry Pi which will be the thin client. Our desktop server is running Ubuntu which comes pre-installed with the Vino remote desktop server that can be accessed via the Desktop Sharing app. The remote desktop functionality is disabled by default. To enable it, launch the Desktop Sharing app and tick the 'Allow other user to view your desktop' box. This also enables the second checkbox which allows the connected users to control the Ubuntu server.

Also enabled is the first option under the Security section which forces you to approve each request for connection. However, for smoother workflow, you'd want to disable this option. Instead, enable the next checkbox which will prompt the user for a password and enter a strong password in the space provided. When you're done, click on the Close button to save the changes. If you use another distro, browse the web and install a VNC server, such as Vino or Krfb, on top of that distro.

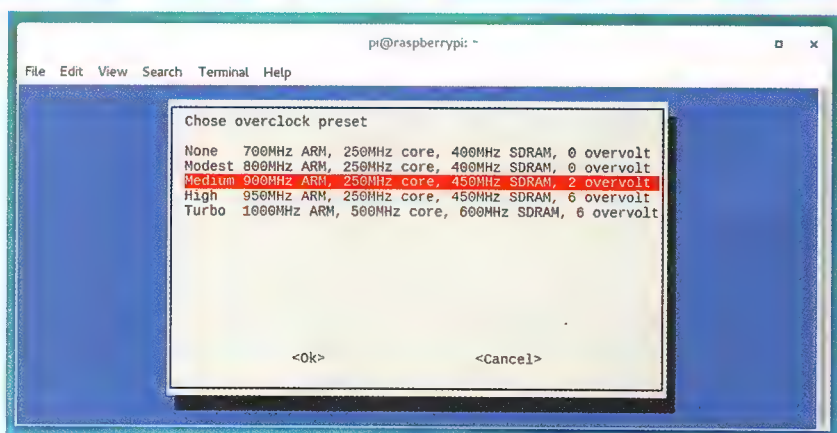
If you're using Ubuntu's Vino you'll have to make one additional change because Vino was changed to require encryption by default, but only supports old encryption methods that are not commonly available. Fire up a terminal on the Ubuntu server and modify Vino's security settings with `gsettings set`

Overclock the Pi

While the Pi's 700MHz processor is good enough to set up these hacks, after a while you'd wish you could squeeze more juice out of it. The good news is that you can! The Pi's BCM2835 processor can be run above its default speed...

However, remember that such performance comes at a price — the processor will draw more power, run hotter than before, and may not last as long as a regular Pi running at its default speed. Also, while it's possible to alter the Pi's performance manually, the safest way is to use the preconfigured overclock settings in the `raspi-config` tool which also doesn't void warranty.

The settings in the `raspi-config` tool are known to be safe for use with most Pis. To overclock your device, launch `raspi-config` and scroll down to the



Overclock option and confirm that you wish to continue. You'll now be shown a list of pre-set overclock speeds and you can select any one. When you have made your selection, the menu will reboot the Raspberry Pi at its new speed.

If the Pi fails to boot with the overclocked setting, hold Shift while booting, which loads the Pi at its stock speed.

`org.gnome.Vino require-encryption false`. Follow the rest of the hack and if you can connect from the Pi, return to the Ubuntu Server and make the settings permanent by installing the `dconf-editor` with `sudo apt-get install dconf-editor` and navigate to `org > gnome > desktop > remote-access` and uncheck the `require-encryption` setting.

You now need to prepare the thin client Pi. For this hack, we'll use the lightweight Remmina client which you can install with `sudo apt-get install remmina`. Once installed it'll be housed in the Internet menu. Launch the client and click on the new icon to configure a connection to the server.

In the window that opens, give this connection a name and select VNC from the Protocol pull-down menu. You'll also need to specify the IP address of the server in the Server field. You can also boost image quality by selecting a higher colour depth and a better quality from the respective pull-down lists. Click Connect when you're done. Remmina will establish a connection to the Ubuntu Server and prompt you for the password you had set before allowing you to take control of remote desktop from the Pi.

HACK #4: HOST YOUR OWNCLOUD

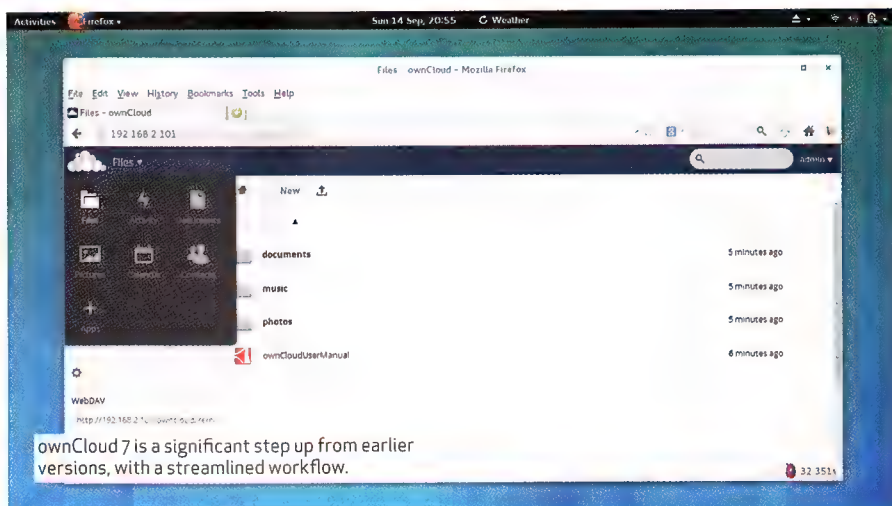
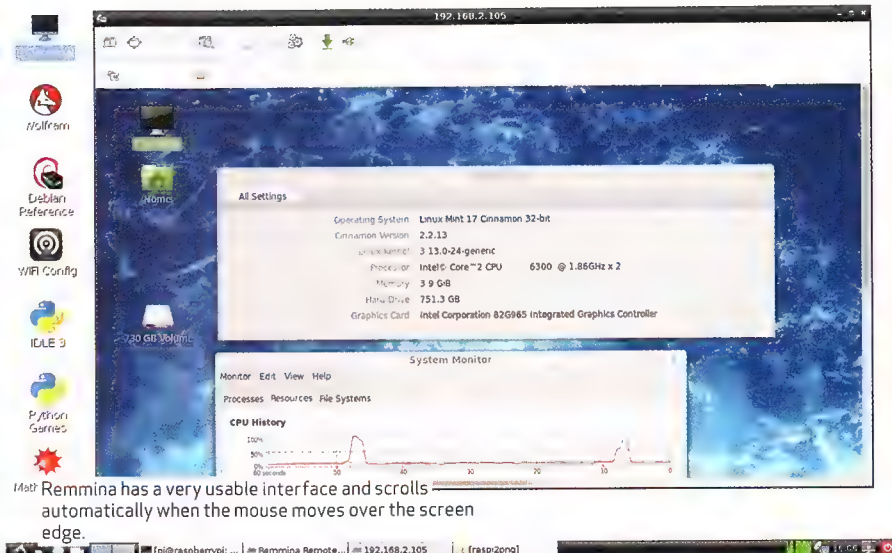
If you want universal access to your data you don't really need to throw money at a service that might store it on servers outside your legal jurisdiction. Instead use the money to get a Pi and a large capacity powered USB disk and host your own private and protected cloud-sharing service with OwnCloud.

OwnCloud lets you sync and share your data and access it from any device connected to the internet. For added security OwnCloud can also encrypt your files. The software can handle files in a variety of formats and has an in-built gallery image viewer and a music player. One interesting feature in OwnCloud is file versioning – because of this, the server tracks all changes to every file and you can revert to an older version with a single click.

Like with other online cloud storage services, you can sync files on OwnCloud either using the web browser or a desktop client on Windows, Mac, and Linux as well as mobile clients for Android and iOS devices.

OwnCloud runs on the Apache web server and also needs a database server. While it can work with MySQL, for this hack we'll use the lightweight SQLite server. You can install all required components with `sudo apt-get install apache2 php5 php5-gd php5-sqlite curl libcurl3 php5-curl`.

Now head to owncloud.org and download the latest tarball. Unwrap it



with `tar xjvf owncloud-7.0.2.tar.bz2` and move the resulting folder into the root of your Apache server with `sudo mv owncloud /var/www`. Then make sure the new files have the correct permissions for their new location with `sudo chown -R www-data:www-data /var/www/owncloud`.

You'll need to enable certain Apache modules for OwnCloud. In a terminal enter `sudo a2enmod headers rewrite env` then restart Apache with `sudo service apache2 restart`. To configure OwnCloud launch a web browser and navigate to the OwnCloud installation at `localhost/owncloud`. Since this is a new installation, you'll be asked to create a user account for the OwnCloud administrator.

You can now log into your OwnCloud server as the administrator and start uploading files you want to share. But before you do that, you'll have to tweak PHP's configuration file if you wish to upload files that are greater than 2MB. To do that, open the PHP configuration file, `php.ini`, housed under `/etc/php5/apache2` in a text editor. Look for the `upload_max_filesize` and `post_max_size`

variables and change their value from 2M to something like 500M or 1G.

You're now all set to upload data into your OwnCloud server using the web interface. You can also interact with the OwnCloud server via the WebDAV protocol. In the location area in the Files file manager, press Ctrl-L to enable the location area. Here you can point to your OwnCloud server, such as `dav://localhost/owncloud/remote.php/webdav`. Once you've authenticated, the OwnCloud storage will be mounted and you can interact with it just like a regular folder.

To share uploaded files, go to the Files section in the web interface and hover over the file you wish to share. This displays several options, including Share, which lets you select who you want to share the item with and if they have permission to edit and delete files.

You can also share an item with someone who isn't on your OwnCloud server. When you click on the Share with link checkbox, OwnCloud displays a link to the item that you can share with anybody. Optionally you can also password-protect the link and set an expiration date.

Skills: Streaming, emulation and GPIO

HACK #5: STREAM WEB MUSIC

We've got music everywhere. In addition to DRM-free tracks on the hard disk, you've probably got hundreds of tracks on Spotify or Google Play. You can get them all together with the PiMusicBox distro which transforms the Raspberry Pi into the ultimate music player.

The PiMusicBox can output music through speakers attached to the headphone jack of the Pi, and also through the HDMI and USB ports. So all you gotta do is install the distro, hook

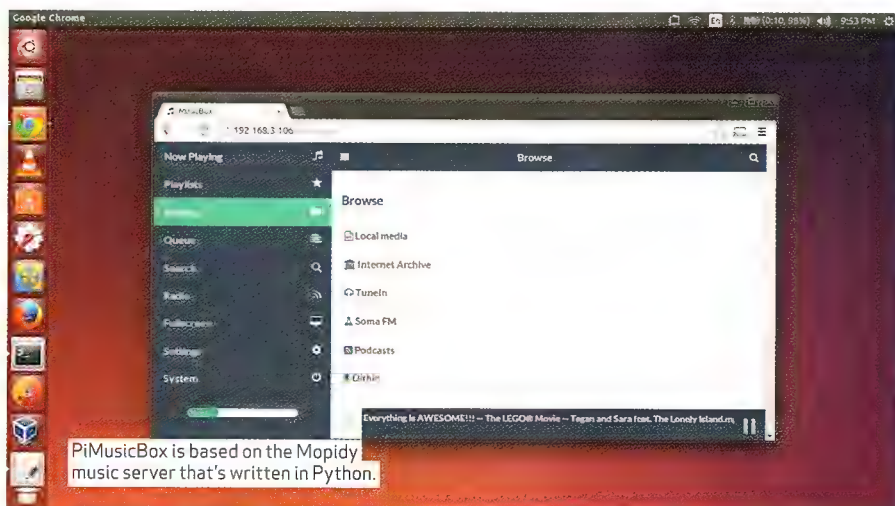
up some speakers, plug in your account credentials and let it rip. You can then control your juiced up Pi from any computer on the network and even from any Android device.

Begin by downloading the compressed image for the PiMusicBox distro from www.pimusicbox.com. Extract the downloaded ZIP file and then put the .img image file on your SD card with the dd command `sudo dd if=musicbox0.5.img of=/dev/sdd`. Remember to replace /d/ev/sdd with the location of your SD card.

If you use the Ethernet port to connect the Pi to the internet, you can boot the Pi from the newly created SD card. However, if you use a wireless card, you'll need to edit the distro's configuration file and manually point it to your wireless router. Access the newly created SD card from a regular distro and navigate to the config folder and open the settings.ini file in a text editor. Near the top of the file you'll notice two variables, WIFI_NETWORK and WIFI_PASSWORD. Insert the corresponding values of your network and save the file. The caveat is that PiMusicBox will only work with WPA2-protected wireless networks.

Once that's done, boot the Pi with the configured SD card. On first boot, the distro will resize the filesystem to take over the complete card, and restart automatically. If you have a monitor attached to the Pi you can follow the booting process, otherwise wait a minute or two, then fire up a browser on any computer on your network and head to <http://musicbox.local>. If that doesn't take you anywhere, then point your browser to the IP address of the Pi.

The default interface of PiMusicBox is rather bland since you haven't configured any music source yet. To fix that, click on the Setting link in the navigation bar on the left. This will take

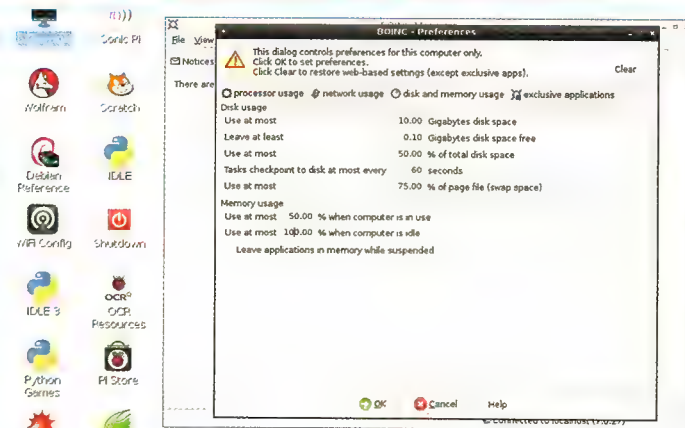


Donate excess resources

If you aren't always using your Pi, you can donate the idle processing power for a worthy cause. BOINC is a computing volunteering service and it uses the donated power for a variety of projects, from protein folding for medical sciences to the search for alien intelligence.

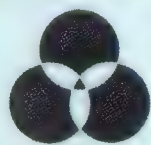
Before installing BOINC, tweak the Raspberry Pi to cut down its own resources utilisation by calling `sudo raspi-config`. Head to 'Advanced Options > Memory Split' and earmark the least possible memory for the GPU which you should find is 16MB. Then install BOINC with `sudo apt-get install boinc-manager boinc-client`.

When it's done, launch the BOINC Manager from the Others menu. You'll be asked to add from one of over 30 supported projects. Some projects



might warn you that they might not have work suitable for the Pi. While you can still add them, it's best to add projects that can make use of the Pi such as the Collatz project, which is attempting to disprove the Collatz Conjecture.

To configure how BOINC uses the Pi's resources, first enable the 'Advance View' and then head to 'Tools > Computing' preferences.



PORTS



3 GAMES AVAILABLE

EmulationStation will only display the emulators that have ROMs added.

you to a page where you can individually enable and configure support streaming services, from premium ones like Spotify and Google Music to free ones like The Internet Archive, Soma FM, and more. You can also control other settings from this page. For example, the Audio setting lets you switch audio output devices.

The PiMusicBox distro has a working Samba configuration and should show up in the Network section inside the file manager of all OS's. The distro's Samba share only has one folder named Music. You can put any audio file inside this folder and they'll be transferred to the SD card. Whenever you restart the Pi, the distro will scan for any new music. You can then browse and play these files from the distro's web interface.

You can also play music via any software that supports the Music Player Daemon (MPD) such as the MPDroid app for Android. To connect, launch the app and in the first-run wizard, enter the IP address of the Pi in the hostname field.

HACK #6: BROADCAST AUDIO

Streaming music is one thing. What if you wish to stream music out to other devices? How about running your own radio station? As it happens, you can do so without too much trouble.

Besides the familiar Audio, Ethernet, HDMI, and USB ports on the Raspberry Pi, the device also has interfaces that are designed to connect more directly with other chips and modules. These General Purpose Input/Output (GPIO) 'ports' are the pins arranged in two parallel strips (26 on the Model B board and 40 on the B+).

These interfaces are not plug-and-play but can be controlled through software. A bunch of hackers over at Code Club wrote a program to use the pins to generate spread-spectrum clock signals to instead output FM Radio signals. To transmit a surprisingly strong FM signal, all you need is to attach a wire to the GPIO 4 pin.

Power up the Pi and bring up a terminal. Now grab the code written at the Code Club and extract it with Wget...

```
http://omattos.com/pifm.tar.gz
mkdir ~/pifm
tar zxvf pifm.tar.gz -C ~/pifm
```

The tarball extracts six files. Surprisingly that's all there's to it. You can now broadcast the included sound.wav file with `sudo ./pifm sound.wav 101.2`. Now grab a FM receiver and set it to FM 101.2 and you'll hear the Star Wars theme. You can change the frequency from between 88MHz and 108MHz by appending the channel frequency at the end of the command.

You can play other audio files as well, but they must be 16-bit 22,050Hz mono and in the WAV format only. That might seem like a limitation but it really isn't with the SoX sound exchange audio editor. The nifty tool processes any MP3 file irrespective of its encoding and converts it to WAV on-the-fly.

Begin by installing the audio editor and its dependencies with `sudo apt-get install sox libsox-fmt-all`. Type in the following command, substituting "SomeSong.mp3" with the name of the MP3 file you wish to play: `sox -t mp3 SomeSong.mp3 -t wav -r 22050 -c 1 - | sudo ./pifm - 101.2`.

The first part converts the MP3 to WAV, changes its audio sampling rate to 22050Hz and down-mixes the track to mono. The converted track is then sent to the standard output, denoted by the hyphen, and is then piped (|) into the standard input of the pifm command.

The only difference in the pifm command in the above example is that instead of specifying the name of the file to broadcast, we are asking the script to instead broadcast the standard input. If you've still got your FM receiver tuned to the 101.2 frequency, you should now hear your MP3.

You can do some wonderful things with SoX. You can, for example, use it to broadcast your favourite streams live from the internet. The command `sox -t mp3 http://www.tuxradar.com/files/podcast/tuxradar_s06e02.mp3 -t wav -r 22050 -c 1 - | sudo ./pifm - 101.2` will broadcast the TuxRadar podcast. The only difference in this command and the last is that instead of pointing to a local MP3, you pointing to one online.

HACK #7: VINTAGE GAMING

Games weren't always graphical masterpieces. Their developers had

fewer resources to play with and instead of graphical excellence the developers relied on gameplay to keep the players hooked. This is why the vintage games even with their rudimentary graphics are still quite popular today.

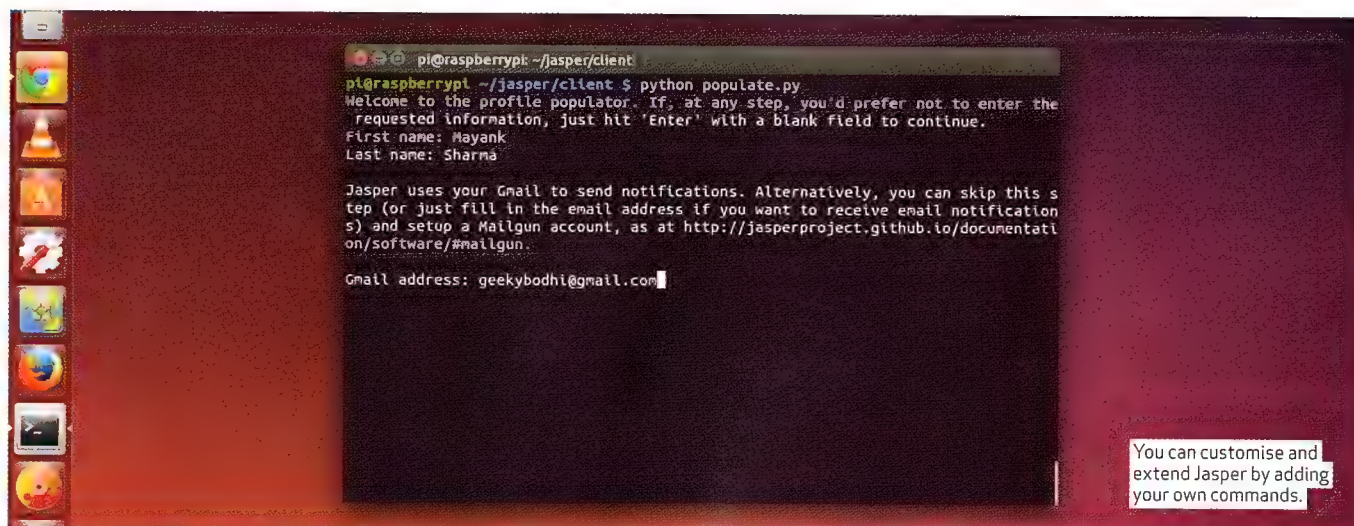
The easiest way to start playing vintage games on the Raspberry Pi is to install RetroPie which packs a bundle of emulators. You can install RetroPie on an existing Raspbian install or run it as a standalone distro. Before you fetch the installation script, grab its dependencies with `sudo apt-get install git dialog`. Then download the latest RetroPie setup script with: `git clone git://github.com/petrockblog/RetroPie-Setup.git`

Now change into the newly cloned directory and run the script with `cd RetroPie-Setup && sudo ./retropie_setup.sh`. The script will download missing dependencies and then present a menu.

The first option downloads and installs precompiled binaries of all the popular supported platforms. The second grabs the newest source code for each app and compiles them on the Pi. If you choose this option, be prepared to wait as it might take almost an entire day. In case you aren't this patient, you might as well grab the image file and transfer it on to a blank SD card with `dd`.

RetroPie uses a graphical front-end called EmulationStation, which allows you to manage the various installed emulators. The RetroPie image automatically starts this frontend, but if you've setup RetroPie on top of an existing Raspbian install, you'll have to launch it manually with the `emulationstation` command.

Once it's up you should see the controller setup screen, from where you can configure your USB gaming controller. In order to play the games, of course, you must first own them. ROMs can be made from your own copies of these old games, or you can find abandonware online. Some companies, such as iD software, have made the original Doom open source and public domain. Once obtained, you'll need to copy them to their appropriate emulator sub-folder inside the `roms/` folder on the SD card.



Skills: Python, eSpeak

HACK #8: MAKE YOUR PI SPEAK

Software speech synthesizers are always very popular to bring computing devices to life. Of course they also have a very crucial role in making the device accessible to vision-impaired users.

You can use the Raspberry Pi for text-to-voice commands thanks to the availability of the powerful eSpeak library in Raspbian's repository. There's also a module that allows you to use eSpeak in Python and allows you to perform automation tasks. Fire up a terminal and use the `sudo apt-get install espeak python-espeak` command to fetch the library and the required Python modules.

Using the eSpeak library is pretty straightforward. Type `espeak "Hello! How are you doing, today?"` in a terminal and the library will use its default settings to verbalise the text inside the quotes. You can then influence the speech of the eSpeak library with a wide array of command-line switches. For example, the command, `espeak -ven+f2 -s140 "Aren't you a little short for a storm-trooper"`, will speak the message at a slower pace and in a female's voice. In addition to the default English voice, eSpeak can also do American English and English with a Scottish accent. Besides English eSpeak can also speak various other languages. The command `espeak -voices` lists all available voice files.

The Python eSpeak module is quite simple to use to just convert some text to speech. Invoke the interactive Python shell with the command `python` and enter the following lines...

```
from espeak import espeak
espeak.synth("How ya doin'?")
```

Now let's use the eSpeak library inside a Python script to print and speak out loud the name of your Twitter

followers. Follow the instructions in the first hack to get the Twitter API and access tokens and their secrets and place them between the single quotes in the code below:

```
import time
from twython import Twython
from espeak import espeak
api_token = ' '
api_secret = ' '
access_token = ' '
access_token_secret = ' '
twitter = Twython (api_token,
api_secret, access_token,
access_token_secret)
next_cursor=-1
while (next_cursor):
    search = twitter.get_
followers_list(screen_
name='geekybodhi',cursor=next_
cursor)
    for result in
search['users']:
        print result["name"]
        their_name=
result["name"]
        espeak.synth(their_name)
        time.sleep(2)
        next_cursor =
search["next_cursor"]
```

In the above code, we connect to our Twitter account and fetch a list of all our followers. We use a technique known as cursoring to separate a large set of results into pages and then move forward through them. The For loop lasts till our list of followers is exhausted. For every follower, the loop prints its name, stores it in a variable (their_name) and then passes it on to the eSpeak library which reads it aloud. It then pauses before moving on.

HACK #9: VOICE CONTROL YOUR PI

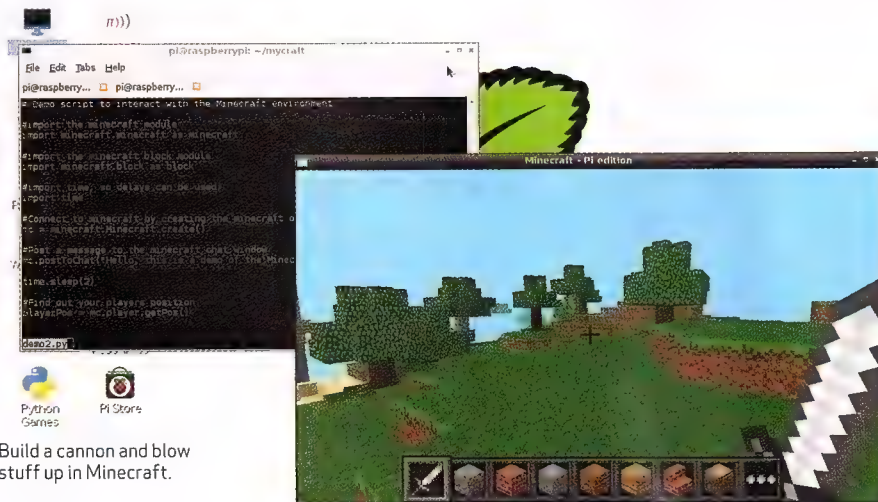
Apple has Siri, Google has Google Now and Microsoft has Cortana. If you think

the Raspberry Pi doesn't have a digital assistant of its own, then you haven't heard of Jasper (who is open source).

To hear Jasper's output you'll need to hook up speakers to the audio port. However, as the Pi doesn't have a mic input, you'll need to find a USB mic that works with the Pi. If you're feeling adventurous you might as well try plugging in a USB webcam – some of these have mics. After hooking up the mic, make sure the Pi recognises it as a recording device with `arecord -l`.

While you can install Jasper on top of an existing Raspbian installation, the recommended way is to use the SD card image. Grab the tarball off the web site (jasperproject.github.io) and extract the image from it with `tar zxvf jasper-disk-image.tar.gz`. Then assuming /dev/sdd is the location of the blank SD card, type `sudo dd if=jasper-disk-image.img of=/dev/sdd` to write the image. When it's done, boot the Pi from the SD card. You can configure Jasper from a remote computer via SSH, so you're ready to get started if the Pi is connected via Ethernet. If you're using Wi-Fi, you'll have to connect a monitor to the Pi, start the X environment and use the graphical Wi-Fi config utility to set up the connection.

The login credentials for the Jasper image is the same as a stock Raspbian distro, that is pi:raspberry. Once the network's been setup, connect to the Pi over SSH. Then in the home directory of your Pi, fetch the Jasper client with `git clone https://github.com/jasperproject/jasper-client.git`. Then upgrade the `setuptools` library with `sudo pip install upgrade setuptools`. When it's done, pull in the required Python components with `sudo pip install -r jasper/`



Build a cannon and blow stuff up in Minecraft.

client/requirements.txt. Finally, set the required permissions inside the home directory with `sudo chmod ??? -R *` and restart.

While it reboots, Jasper will run the `boot.py` script and generate the `language_model.lm` file in the `~/jasper/client` folder. Make sure the file has been created. If not, you can manually invoke the `boot.py` script with `python ~/jasper/boot/boot.py`. Once the language model file has been created, proceed to create a user profile for Jasper to get to know you. Change to the `~/jasper/client` directory and run the profile population script with `python populate.py`. The script will ask for information such as your name, contact details, etc. Jasper uses this information to communicate with you and respond to your queries more accurately. Also remember that Jasper will ask you for the password for your email account and then store it as plain unencrypted text. The details are stored in the `profile.yml` file. Follow the documentation on the project's web site to integrate other services such as Facebook and Spotify. Restart the Pi again after you've run through the profile creation script.

When it's back up, Jasper will greet you with the speech synthesizer you selected while creating the profile. You can now start interacting with your new assistant by saying 'Jasper'. If it catches the phrase, Jasper will respond with a beep. You can now speak your command such 'What's the time', or 'Do I have new email?'. Again, if Jasper can hear you it will respond with the answer. Depending on the quality of your mic and the oratory skills of the operator, your initial conversations might not be very pleasant.

HACK #10: MINECRAFT PI EDITION

The Minecraft Pi Edition is a cut-down version of the popular Pocket Edition but includes enough components to unleash your creativity. You can

explore randomly generated worlds and use the construction mode to build your own creations.

The best thing is its API, which can be accessed using Python. You can write Python scripts to move the player as well as create and destroy blocks. This allows you to create structures in seconds that would take hours to create by hand. The API also lets you create interactive objects such as clocks and equips you with teleportation powers.

To install the Pi edition, head to **pi.minecraft.net** and download the compressed archive. Then extract it under your home directory with `tar xzvf minecraft-pi.tar.gz`. This will inflate the archive under the `~/mcpi` directory. Switch to the directory and launch the game with `./minecraft-pi`.

You can use the API to connect to a running Minecraft instance. However, before you take control with the Python API, it's a good idea to make a replica of the Python API folder from within the `~/mcpi` folder to a new location. In the terminal, type `mkdir ~/mycraft` to create a folder and copy the API into it with: `cp -r ~/mcpi/api/python/mcpi ~/mycraft/minecraft`

We'll save our custom scripts inside the `~/mycraft` directory. While the game is running, press the Alt-Tab keys to switch back to the terminal. Open a new tab in the terminal and change into the `mycraft` directory. Fire up a text editor and create a new `demo.py` script with `nano ~/mycraft/demo.py` and copy the following into it:

```
# Demo script to interact
with the Minecraft environment
import minecraft.minecraft as
minecraft
import minecraft.block as
block
import time
#Connect to minecraft by
creating the minecraft object
mc = minecraft.Minecraft.
create()
#Post a message to the
```

minecraft chat window

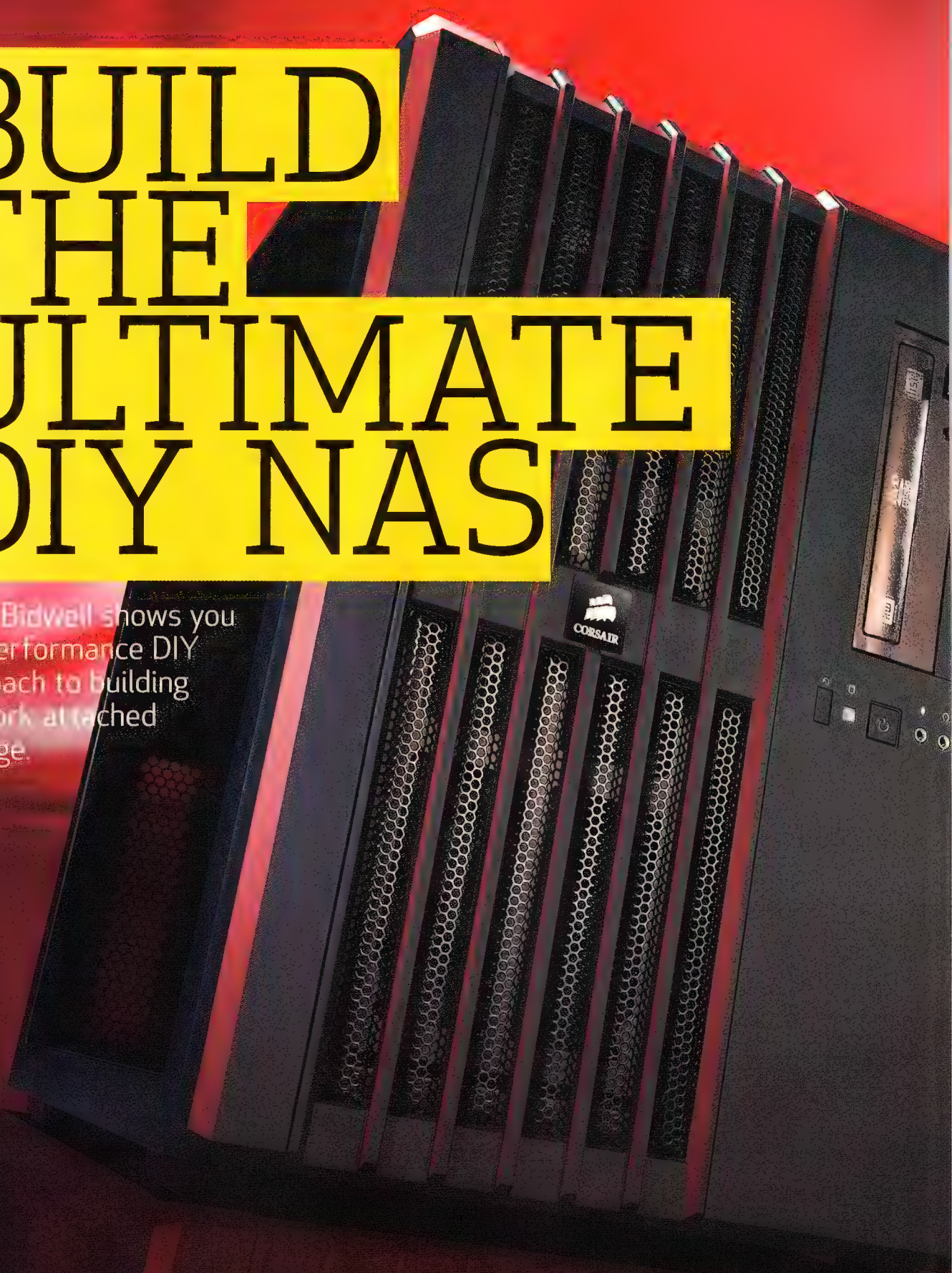
```
mc.postToChat("Hello, this
is a demo of Minecraft API.")
time.sleep(2)
playerPos = mc.player.
getPos() #Find your player's
position
#Change your players position
mc.postToChat("Let's teleport
you 50 blocks in the sky!")
time.sleep(2)
mc.player.
setPos(playerPos.x+50,playerPos.y
+ 50,playerPos.z)
# wait for 10 seconds while
you fall back
time.sleep(10)
# - create a STONE block in
front of you
playerPos = mc.player.
getTilePos()
mc.setBlock(playerPos.x+1,
playerPos.y+1, playerPos.z,
block.STONE)
time.sleep(5)
# - Now change that block
into WOOD
mc.setBlock(playerPos.x+1,
playerPos.y+1, playerPos.z,
block.WOOD_PLANKS)
time.sleep(5)
# - Now let's create a tower
by stacking block
for top in range(0, 10):
mc.setBlock(playerPos.
x+3, playerPos.y+top,
playerPos.z, block.STONE)
time.sleep(5)
# - Let's now teleport you to
the top of the tower
mc.player.setPos(playerPos.
x+1, playerPos.y+10,
playerPos.z)
```

Save the script and while Minecraft is running, fire up the script with `python ~/mycraft/demo.py`. You'll see the welcome message in the game as defined in the `postToChat` string. We then find your player's position with `getPos` and store it in the `playerPos` variable. The players position is defined with the X, Y and Z coordinates that you can see in the top-left corner of the screen. We then use `setPos` to change your position and teleport you into the sky. When you fall back down, we use the `setBlock` parameter to create a stone block (`block.STONE`) in front of you and then after five seconds replace it with a wooden block (`block.WOOD_PLANKS`). We then use a `For` loop to stack ten stone blocks a little further away, and then place you on top of it before ending the demo.

This is really just a demo of the things that are possible with the Python API. Download this neat PDF cheat sheet (tinyurl.com/kjzyeuk) of the parameters in the API along with examples and brief descriptions.

BUILD THE ULTIMATE DIY NAS

Jonni Bidwell shows you
the performance DIY
approach to building
network attached
storage.



As storage gets ever cheaper and appetites for data become ever more voracious, more and more people are looking to NAS (network-attached storage) boxes to store their bits. All manner of off-the-shelf units are available from myriad manufacturers at a variety of prices. Two and four disk setups are the most common, offering a simple and compact out-of-the-box solution to home storage.

It may come as no surprise that Linux is at the heart of many of these technologies, since they are just modestly specified x86 or ARM boxes belied by fancy web interfaces and easy-to-use configuration software.

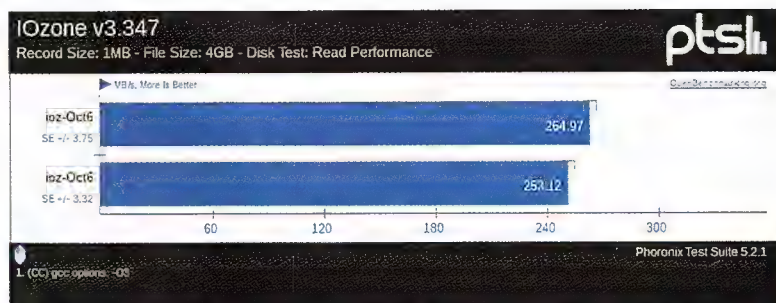
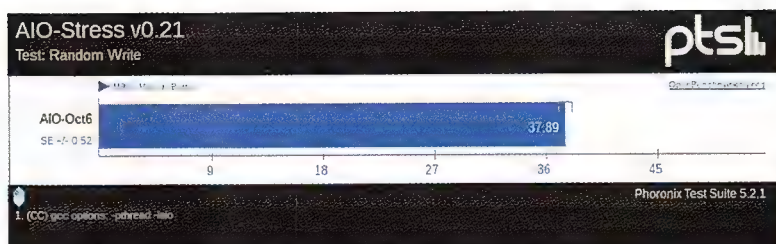
Indeed, the impecunious can save a few dollars by making their own NAS device. There are a few purpose-built open source NAS distributions, the most popular trio being connected in a confusing and incestuous manner: the BSD-based FreeNAS (a rewrite of an older project of the same name), NAS4Free (a continuation of the original FreeNAS code), OpenMediaVault (a Debian-based project by the original author of FreeNAS). These are all great projects, and will set up everything for you: from building the array to sharing your Chris de Burgh bootlegs and other files. But what if you want to set everything up yourself? Maybe you want your NAS box to double as a media centre, or use it to stream Steam games from a Windows box, or run an OwnCloud installation? Maybe you just like to be in control, especially in light of Shellshock attacks targetting web-facing NAS boxes. Without further ado, let's find out how.

In terms of hardware, the most important part is the drives. You could make a simple storage box with a single large drive, but it's worth investing in more so that you can have some redundancy. For a RAID setup you'll want somewhere between two and six drives, and things are simpler and more efficient if they are the same size. With two drives you can have a RAID1 configuration (where one drive is a mirror image of the other), with three drives you can have RAID5 (where data and parity blocks are striped across the drives for increased performance and integrity). We've gone for four drives, mostly because the generous folks at Western Digital sent us four Red series 6TB drives.

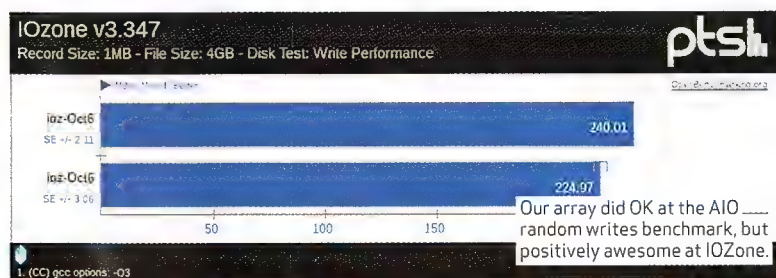
ARRANGING RAID

With four drives a number of RAID configurations are possible, which we'll briefly summarise here. RAID10 is a combination of levels 1 and 0, so that we would first set up a two-disk RAID0 array (which offers no redundancy but

IOZONE



IOZONE



doubles performance) and then mirror it. RAID5 is again possible, but not really recommended since if you lose one drive then the I/O intensive rebuild will greatly increase the chance of losing another — and hence all your data. RAID6 provides insurance against two drive failures, offers a small speedup thanks to striping, and is what we opted to use in our build. We should end up with 12TB of usable

space and transfer rates twice as fast as a single drive.

While it's possible to put an OS onto a separate partition on one of your RAID drives, we wouldn't recommend it: you'd have to downsize all your RAID partitions accordingly and it's generally a good idea to keep these things separated. Installing the OS inside the array is also possible, so long as the bootloader has its own partition

Component selection

Besides disks you needn't worry too much about hardware. The machine need not be powerful, there's no need for fancy graphics and unless your going to use ZFS 4GB of RAM will be more than enough. HP Microservers are a popular choice, but they're not exactly the most stylish of boxes. Besides, it's fun to build it all yourself. Maybe you've already got a micro ATX case/mobo lying around, and if not you can build a cosmetically pleasing mini ITX setup without significant outlay. If the machine is going to be running 24/7 in your living room then you probably want some quiet components. Make sure airflow is good around the drives, as they can get hot.

Controversially, we opted for an AMD Kabini 5350 APU (quad core, 2.05GHz, R3 graphics). The Kabini series, aimed at high-growth low-cost markets, was launched in April and features a miniscule 25W TDP, so overheating shouldn't be a problem. The on-chip controller natively supports only two SATA drives, but 2-port PCI-Express cards are cheap. Just make sure to get one that supports FIS-based switching (ie nothing based around the ASM1061 chip). If you prefer chipzilla, then the J1900 Celeron is a good and cheap CPU to go for. There are plenty of Mini-ITX motherboards that come with one built in. Like the AM1 boards, some allow power to be supplied by a standard 19V laptop brick.


```

Error logging capability: (0x01) Error logging supported.
General Purpose Logging supported.

Short self-test routine
recommended polling time: ( 2) minutes.
Extended self-test routine
recommended polling time: ( 727) minutes.
Conveyance self-test routine
recommended polling time: ( 5) minutes.
SCT capabilities: (0x303d) SCT Status supported.
SCT Error Recovery Control supported.
SCT Feature Control supported.
SCT Data Table supported.

SMART Attributes Data Structure revision number: 16
Vendor Specific SMART Attributes with Thresholds:
ID# ATTRIBUTE_NAME          FLAG     VALUE WORST THRESH TYPE      UPDATED  WHEN_FAILED RAW_VALUE
 1 Raw_Read_Error_Rate     0x002f   200    200    051 Pre-fail  Always         0
 3 Spin_Up_Time            0x0027   206    203    021 Pre-fail  Always       8691
 4 Start_Stop_Count        0x0032   100    100    000 Old_age   Always        15
 5 Reallocated_Sector_Ct   0x0033   200    200    140 Pre-fail  Always         0
 7 Seek_Error_Rate         0x002e   200    200    000 Old_age   Always         0
 9 Power_On_Hours          0x0032   100    100    000 Old_age   Always        48
10 Spin_Retry_Count        0x0032   100    253    000 Old_age   Always         0
11 Calibration_Retry_Count 0x0032   100    253    000 Old_age   Always         0
12 Power_Cycle_Count       0x0032   100    100    000 Old_age   Always        15
192 Power-Off_Retract_Count 0x0032   200    200    000 Old_age   Always         5
193 Load_Cycle_Count       0x0032   200    200    000 Old_age   Always        19
194 Temperature_Celsius    0x0022  123    110    000 Old_age   Always        29
196 Reallocated_Event_Count 0x0032   200    200    000 Old_age   Always         0
197 Current_Pending_Sector  0x0032   200    200    000 Old_age   Always         0
198 Offline_Uncorrectable   0x0030   100    253    000 Old_age   Offline        0
199 UDMA_CRC_Error_Count    0x0032   200    200    000 Old_age   Always         0
200 Multi_Zone_Error_Rate   0x0008   100    253    000 Old_age   Offline        0

SMART Error Log Version: 1
No Errors Logged.

```

Smartmontools can use your drives' SMART data to prophesy imminent hardware problems.

and your initrd image has mdadm (Multiple Disk Administration) support. Again, not suitable for a storage box.

We used up all the internal bays (and SATA connections) in our wee tower, so our OS had to go on a rather nice WD Black2 USB3 hybrid drive. This is fine so long as you don't accidentally dislodge said stick while the machine is running. For a simple NAS box you're not going to want a full-blown desktop environment, so we'll start with a plain Arch Linux install. If you want to add media centre functionality further down the line then Arch will not stop you. You can read all about installing Arch onto a USB drive here (tinyurl.com/233bgx2). The rest of our guide will loosely translate to other distributions too, so we'll assume you've set up a barebones install with a working internet connection. It's a good

idea to set up an SSH server on your machine (for when things go wrong), and also set up a static IP. These steps are well documented elsewhere, so we'll assume you've done them. So you can unplug the keyboard and monitor and continue to build the machine remotely.

First, you'll want to partition your disks. If your drives are larger than 2.2TB, then you'll need to use a GPT partition table. Even if they're not you may as well do so anyway. The gdisk program is your friend here, it's part of the gptfdisk package on Arch: `# gdisk /dev/sda`

Create a new partition by entering `n`, then press Enter again to accept that it is the first partition, press Enter again to accept the default start sector [2048]. It's a good idea to leave at least 100MB free at the end of each drive, since drives purporting to be of the same

capacity often are off by a couple of cylinders. You can either do some math here to work out exactly which sector to end the partition on (multiply your drive size in terabytes by 2 to the power 40, subtract 100 times 2 to the power 20, divide that by 512 (each sector is probably 512 bytes), add 2048, bam) or you can just use, for example, `+5999.9G` for something like 100 megs short of 6TB. RAID partitions ought to get the special partition type `FD00`, although Linux doesn't really pay attention to this anymore. Write the new partition table to the disk by entering `w`. Repeat this for all the disks you want to include in your array.

SETTING UP YOUR ARRAY

The most exciting and time consuming part of the operation is setting up the array. Much of the complexity is

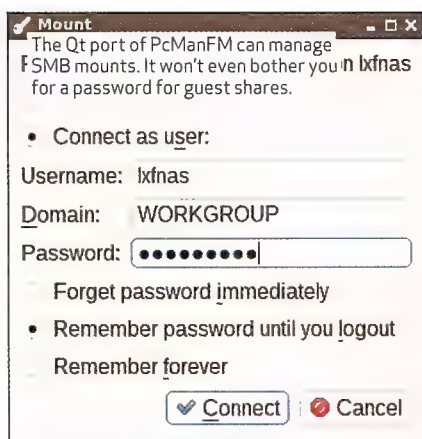
RAID Alert

You'll see this warning on any RAID article but we'll add it into ours anyway: RAID isn't the same as backing up! RAID is only a first line of defence, and will not protect you from accidental deletions. (And neither fire, electromagnetic pulses nor dark wizards.) If your data is really important, you must back it up off-site. This tutorial shows you how to set up software RAID and it is worth dispelling some myths on this topic.

Dedicated hardware RAID controllers are available, though at a premium. For the most part, they are not necessary either — certainly there is a small processing cost associated with calculating parity bits, but on modern hardware this is negligible. Also hardware controllers typically use proprietary disk layouts, so if your controller fails you need to replace it

with an identical one in order to get at your disks. A software RAID array can be accessed by any Linux OS via the mdadm command. Hardware RAID controllers can also be very fussy about SATA drive compatibility, with software RAID if the OS can see the drive, then it can RAID it.

Finally, your motherboard may claim to support various RAID configurations. This is what is known as FakeRAID, or sometimes host RAID. Despite the slightly derogatory name (the onboard controller passes all the RAID calculations to the CPU), this is still a robust setup (though usually it only supports RAID 0, 1 and 10) and will enable you to stripe your boot drive and in some cases even recover your array from the BIOS. Sometimes though, recovery requires you to use Windows software. Sorry, but it's true.



obviated by the mdadm abstraction layer, but make sure you get the parameters correct – the partitions you specify will be irrevocably wiped.

For example, our RAID6 array came into being by the following incantation:

```
# mdadm --create --verbose
--level=6 --metadata=1.2
--chunk=256 --raid-devices=4 /
dev/md0 /dev/sda1 /dev/sdb1 /
dev/sdc1 /dev/sdd1
```

The command will run in the background for a long time (our array took 24 hours to create) and you can monitor progress by looking at the status file: `# cat /proc/mdstat`

You can start using your array in degraded mode immediately, but patience is a virtue, so why not go read a book and drink several cups of tea? Or you can ponder whether 256K was a good choice for your chunk size. Chunk size refers to the size of each section of data as it is striped across drives. The default is 512K, but the optimum value depends on your hardware and use case. For larger files it's recommended to use smaller chunks, so that data is spread across more drives, but with only a handful of drives this logic doesn't really apply. For smaller files one should use larger chunks, but not orders of magnitude larger than the size of the files your working with. If you're determined to find the optimum, then you really have to put in some hours benchmarking your setup. Bear in mind that even if you're using Gigabit Ethernet to access your NAS the network will likely still be the bottleneck, so in this sense fine-tuning RAID parameters is moot. The value that you settle for is important when we initialise our filesystem though.

You need to tell mdadm about your array so that it can be easily accessed after a reboot. Do this by running: `# mdadm --detail --scan >> /etc/mdadm.conf` which will add a line something akin to

```
ARRAY /dev/md0 metadata=1.2
```



```
name=wdarray:0 UUID=35f2b7a0:9
1b8b477:bff71c2f:abc041b2
```

to mdadm's config file.

The device node `/dev/md0` can now be treated like any other partition, albeit a massive 12TB one in our case. So let's format it in preparation for a massive dump (of data). We're going to use ext4 which is perhaps a conservative choice, but it's robust and modern. More exotic filesystems scale well to tens of drives and can manage even your array independently of mdadm, but ZFS needs lots of memory (expensive ECC memory is strongly recommended) and Btrfs can cause CPU spikes. Ext4 has a couple of RAID-specific options `stride` and `stripe-width` and it's important to get these right so that RAID chunks and filesystem blocks are aligned. Stride is the number of filesystem blocks spanned by each chunk, so calculation is `chunksize/blocksize`. Ext4 uses 4k blocks by default (though you can use smaller ones via the `-b` option if you want), so each of our 256k chunks span 64 blocks. Stripe width is this figure multiplied by the number of data disks. In our four-disk array, each chunk is spanned across two disks and

the other two are devoted to the chunk's parity, thus our stripe width is 128 blocks. If we were using RAID5, then only one disk would be a parity disk, but we're not so we formatted the array with the following:

```
# mkfs.ext4 -v -L wdarray -m
0.5 -E stride=64,stripe-
width=128 /dev/md0
```

The `-m` option sets the percentage of the partition to reserve for the super-user. This defaults to 5%, which is a little high for large volumes.

SAMBA: SHALL WE DANCE?

We'll want to add at least one user called `lxfraid`, and change the permissions on `/mnt/raid` to allow them to access our data silo:

```
# groupadd raidusers
# useradd -m -G raidusers -s
/bin/bash lxfraid
# chown root:raidusers /mnt/
raid
# chmod 775 /mnt/raid
Now we can start installing all the
packages required. # pacman -S
samba
```


As well as having a system account, Samba users will need to have an entry in the smbpasswd file. This is achieved with: `# smbpasswd -a lxfraid`

Now edit and read the file `/etc/samba/smb.conf`, there's a few things you might want to enable and disable. First, uncomment and edit the hosts allow line so that Samba access is restricted to the local network (eg 192.168. or 192.168.0.) and loopback interface only. Towards the end of the file you'll find the Share Definitions section. Add the following block to make a share for our array:

```
[[raid]]
comment = LXF RAID
path = /mnt/raid
public = no
valid users = lxfraid
writable = yes
```

Later you can add more and put them in the raidusers group and set up permissions. If you want to set up a public area that doesn't require authentication, first make a directory:

```
# mkdir /mnt/raid/public
```

By default guest accesses are mapped to the unprivileged user nobody, so if write access is needed you'll need to `chmod 777` this directory, and uncomment the last line in the following share definition.:

```
[[public]]
comment = Guest area
path = /mnt/raid/public
public = yes
read only = yes
writable = yes
```

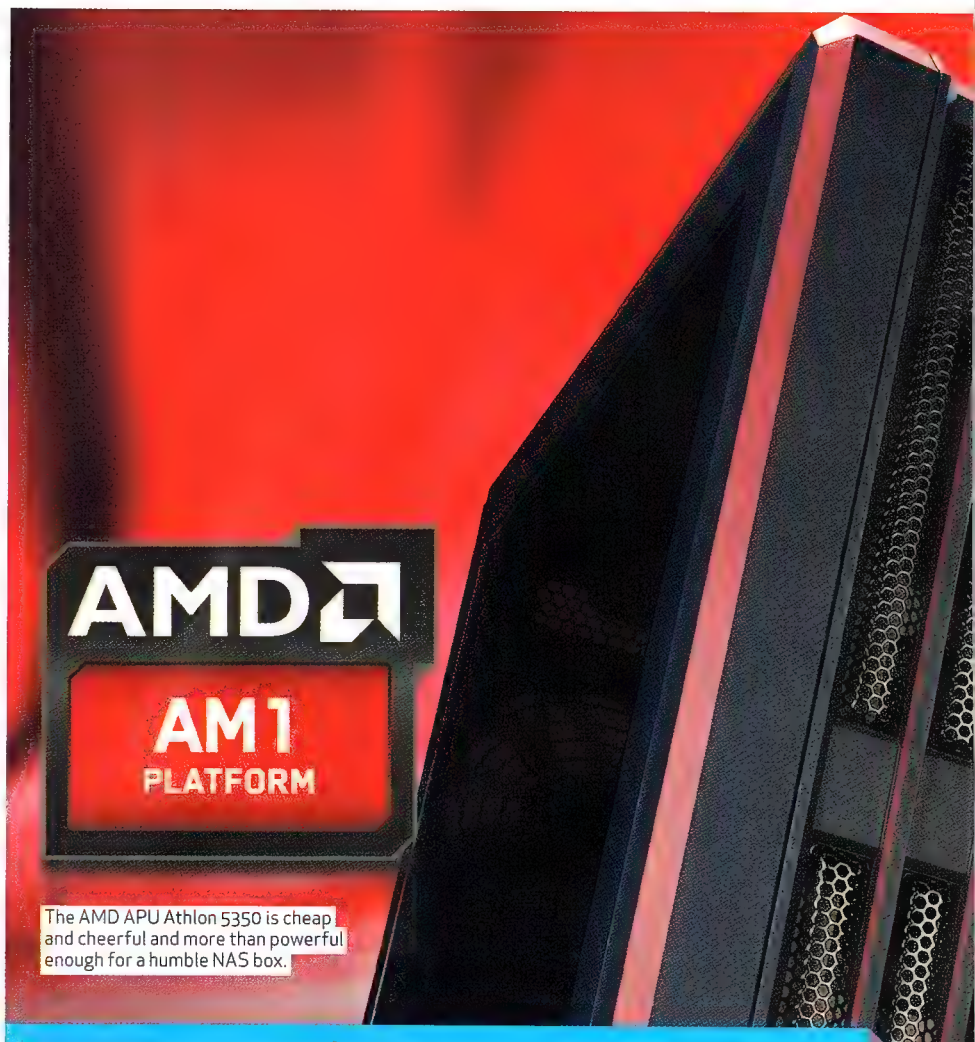
Alternatively, to allow write access only for users in the raidusers group:

```
# chown lxfraid:raidusers
# chmod 775 /mnt/raid/public
```

and then add the following inside the [public] definition: `writelist = @raidusers`

Now we can start the Samba services and test our server: `# systemctl start {smbd,nmbd}`

You should be able to access the Samba shares from anywhere on your network. The nmbd service will let you look up your Samba shares using the `\\hostname` (Windows) or `smb://hostname` (Mac/Linux) URI's. But this can be temperamental and you may have better luck using your IP address here. Nautilus and Dolphin will let you browse workgroups from the Network section. Machines wanting to see SMB shares will need at least the smbclient package installed in order to browse and mount network shares. If you can't access your shares then good luck troubleshooting – the testparm



DuckDNS setup

You can sign up to the DuckDNS service at www.duckdns.org using Twitter, Facebook, Reddit or Google+. If you are an off-grid sort, then you'll need to decide which is the lesser of these four evils and create a special account. Change to the lxfraid user and create our DuckDNS updater script:

```
# su lxfraid
# mkdir ~/duckdns
# cd duckdns
# nano duck.sh
```

Enter the following, replacing the domains and token appropriately.

```
echo url="https://www.duckdns.org/update?domains=your_
domain&token=your_token&ip=" | curl -k -o ~/duckdns/duck.
log -K -
```

Then make it executable and give it a test run:

```
# chmod 700 duck.sh
# ./duck.sh
```

You should get some output from curl, and hopefully the duck.log file should now contain the encouraging text OK. To run this automagically, you'll need to install a cron daemon, let's use the simple cronie: `# pacman -S cronie`

The next command (reverting to the lxfraid user) will open an empty crontab (using the nano editor so as not to induce any inevitable vi-rage): `# EDITOR=nano crontab -e`

Add the following line to run duck.sh every five minutes: `*/5 * * * * ~/duckdns/duck.sh >/dev/null 2>&1`



AM1 motherboards are limited when it comes to choice and features, but they're all pretty small.

"Since your external IP address is likely to change you'll want to set up a dynamic DNS."

command is a good place to start, it will check your smb.conf for anomalies. You can then set these services to start automatically by replacing start with enable.

If you want to automatically mount your server from another machine on your network then you can add an /etc/fstab entry akin to the following:

```
//192.168.133.225/raid /mnt/
raid cifs
username=lxfraid,
password=password 0 0
```

Storing passwords in this way is obviously not secure so only use this on machines where no one is going to pry. Also if for any reason the Samba service is not running, like the box is turned off, then startup on a machine with an fstab entry like this will be slowed down.

OPENING UP TO THE WORLD

Sometimes it is desirable to make your NAS accessible via the internet. This isn't something you should do lightly, and nor is it something you should do using Samba. One way is to forward port 22 on your router to your NAS, and connect via SFTP. Make sure you've

locked down the SSH server, in particular the line PermitRootLogin without-password is a good idea. This will restrict root access to public key only, so you'll need to generate one with ssh-keygen and add it to the /root/.authorized_keys file. You could also disable root logins altogether by setting the above option to no, but then you'd have to do any admin tasks locally, ie plugging a keyboard and monitor into your NAS box.

Since your external IP address is likely to change you'll want to set up a dynamic DNS using a service such as DuckDNS, dyndns or no-ip. These services enable you to run a script or client program on your machine which will update the DNS mapping for your IP address. By setting up a cron job to run this periodically your machine will always be accessible by a constant domain name. Signing up to any of these services is straightforward, but DuckDNS enables you to update things by a simple script, which befitting of the Arch KISS philosophy. Follow the instructions in the box (see left) to get it set up.

For the most part, your RAID will take care of itself. But keep an eye on /proc/mdstat - an entry like [UUUU]

implies that everything is working fine, if a drive fails then you will instead get an F in this list. You can also get lots of information from: # mdadm --detail /dev/md0

Those who prefer to go for a more hands-on approach will enjoy regularly 'scrubbing' their array. (There's nothing wrong with that after all.) This will check for any inconsistencies between the data and parity blocks, and will go on to try to repair them automatically. To initiate a scrub: # echo check > /sys/block/md0/md/sync_action

This will take a while, the mdstat file will track its progress, but if you want to cancel it at any time then you'll need to run: # echo idle > /sys/block/md0/md/sync_action

There's so much more you could do with your NAS, but we've run out of space this time to write more. Why not write to us and tell of your NAS-related adventures? ■





BUILD A PC FOR OCULUS RIFT

The Oculus Rift could be the biggest thing to hit gaming since *Doom*. Make sure you have the right equipment to fully experience the revolution.

You might have heard about the Oculus Rift (especially if you're a regular reader of APC). It started life as a Kickstarter campaign to create a wearable virtual reality head-mounted display that can be connected to your PC.

Its aim was to finally live up to the potential of virtual reality by making us feel as though we are really inside the game — and avoiding the headache-inducing problems of its forebears. Some of us are still dizzy from trying Nintendo's Virtual Boy in the '90s. The Oculus Rift's potential has led to it being incredibly successful — and it hasn't even been officially released yet. When Facebook buys you for \$2 billion, you know you're on to something pretty amazing.

What makes the Oculus Rift stand out from the failed virtual reality offerings of the past is that it has successfully achieved presence when running in-game. What this means is that when you're wearing the Oculus Rift, your brain can be fooled into believing that you actually are in the game world. This is achieved through a number of technologies that work together to make the virtual reality of the Rift as convincing as possible. Needless to say, for this level of immersion, you're going to need a very capable PC.

Part of the appeal of the Oculus Rift is that you'll be able to plug it in to almost any PC. At the moment, there aren't any minimum system requirements to use the device — all it needs is an HDMI or DVI video-out port, which almost all recent PCs have. However, just because you can plug the Oculus Rift into your Windows Vista laptop with 1GB of RAM and onboard graphics, doesn't mean you should. The more powerful your computer, the better the virtual reality

experience will be — so if you really want to achieve presence in-game, you might have to be prepared to perform some upgrades. However, the promise offered by the Oculus Rift means that it will be well worth the expense. Here's how to get your rig VR-ready.

If the Oculus Rift hasn't officially launched yet, why would you think about upgrading your PC already? Well, to start with, just because the consumer version isn't available to buy, it doesn't mean you can't use an Oculus Rift right now. The Oculus Rift DK2 (Development Kit 2) is currently being shipped out to people who have pre-ordered it, or supported Oculus Rift on Kickstarter. Although it's primarily designed for developers who

want to make, or port, their applications and games to the Oculus Rift, it does contain a number of advancements over the original Development Kit, most of which will make it to the consumer version when it releases. If you simply can't wait to try the Oculus Rift (and who could blame you?) the DK2 is a good choice.

It's also wise to begin planning your upgrade in preparation for the release of the consumer version from a practical perspective. You don't necessarily have to go out and buy all the new components immediately, but it's a good idea to know exactly what you'll need to upgrade so your PC is ready when the consumer version launches. There's very little worse than

owning a new toy that has to remain in its packaging because your current PC isn't up to the task.

GRAPHICS

The biggest strain the Oculus Rift is going to put on your PC is in the graphics department. Realistic graphics aren't the be-all and end-all of creating immersive effects in virtual reality. After all, we're seeing some very exciting Oculus Rift projects that make use of stylised graphics, rather than photo-realistic ones. But there will no doubt be some very graphically demanding games that will look phenomenal, and you'll want your PC to be able to handle them.

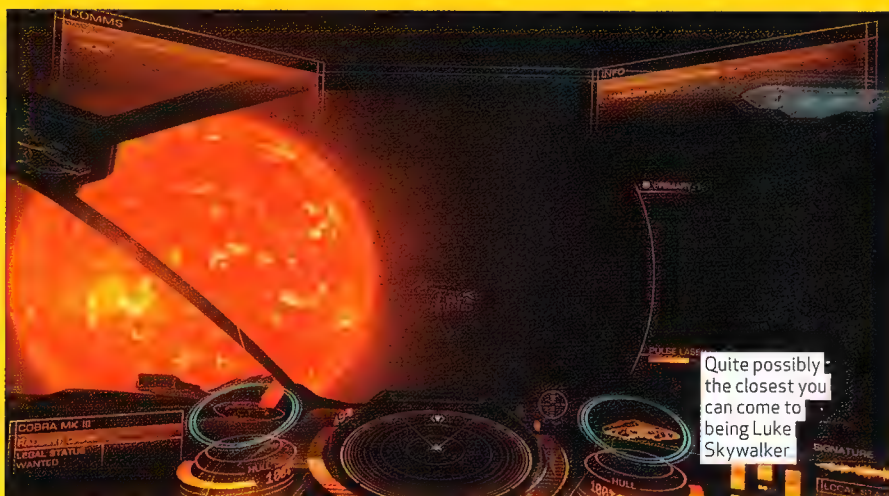
It's also worth noting that for the best levels of immersion, the DK2 model uses two OLED screens (one for each eye) that display a resolution of 960 x 1,080 each. So not only will your graphics card need to be powerful enough to display impressive graphics, but it will have to be able to do it twice.

There are rumours that the consumer version may ship with even higher resolutions. In the future we may even see an Oculus Rift that can handle 4K — great for immersion, but your GPU will struggle. At a minimum, the Oculus Rift needs to display the graphics at a 60Hz refresh rate. While this is pretty standard for most monitors, for the best effect you'll want to be able to display the graphics at 75Hz. In order to keep the virtual reality world around you from feeling sluggish — or having a sense that things are slightly in slow motion — or from causing motion sickness, latency is also an important factor to keep down, with a system latency of 50 milliseconds being the current goal (although ideally it would be under 20).

John Carmack, Oculus VR's CTO and a no doubt familiar name for PC gamers, has been particularly concerned with latency issues in modern GPUs. He was also seen at the launch of Nvidia's G-Sync project, so there is a good chance that there have been ongoing discussions with Nvidia about including virtual reality optimisations in its new GPUs. With the launch of the GeForce GTX 970 and 980 there are newer options available too. We also recommend going with a GPU with at least 3GB of GDDR RAM, though 4GB or more would be preferable, thanks to the high resolutions needed for an optimal virtual reality experience.

PROCESSOR

While the GPU of your Oculus Rift rig will be doing most of the heavy lifting, it doesn't mean you should neglect your processor. In the past, when deciding what processor to go for, the choice between an AMD or Intel CPU was



The best games for the Oculus Rift

You've got your rig sorted — it's time to get some games fired up to really see what it can do.

Because it's still very much in its infancy, the Oculus Rift might have the potential to be compatible with some current games — thanks to the vorpX 3D driver that's designed to port existing games to the Rift — but not every game will be playable. You can find out more and download vorpX from www.vorpx.com.

Meanwhile, for some specially designed games that make the best possible use of Oculus Rift thanks to native support, be sure to check out *Euro Truck Simulator*, which offers an excellent, and rather relaxing, virtual reality experience. If that's a little tame, why not try out base jumping without having to leave your chair and fling yourself into a dangerous-looking hole? Check out *Aaaaa! — A Reckless Disregard for Gravity*, which reproduces an impressive feeling of speed (and vertigo) with the Rift.

Perennial favourite *Team Fortress 2* has been given a new lease of life thanks to native support for Oculus Rift being

included by producer Valve, which has also highlighted its support for virtual reality by including native support in its classic *Half-Life 2*. There are some incredibly impressive videos floating around that there internet currently, showing people playing *Half-Life 2* with the Oculus Rift and Razer Hydra motion controls.

As we mentioned earlier, although first-person shooters can benefit from Oculus Rift support, the best examples at the moment are games where you sit in a cockpit and control a vehicle — preferably one fitted with huge guns. This is why *Hawken* is such a great fit, because you'll really feel you're inside a huge mech. *Elite: Dangerous* is another fantastic example of this, especially when paired with a joystick. We've been zooming around the galaxy in our dinky spacecraft as often as we can — it's an amazing experience.

pretty close, and often boiled down to budget or personal preference. These days, the choice is a lot easier — sadly not because of what Intel is doing right, but what AMD is doing wrong. It's also a bit of an open secret that Intel has been taking an interest in virtual reality in general, and Oculus Rift in particular. Intel is keen to have its chips as the de facto choice for VR enthusiasts, and we're inclined to agree, because it has been showing some interesting technological advances coming out of its R&D department regarding improving the virtual reality experience, such as using bicubic texture lookups and barrel distortion to help improve the appearance of graphics when wearing a head-mounted display.

AMD hasn't been neglecting VR either, though what we've heard so far from the company about VR has been mainly to do with its graphics cards. If you have a Sandy Bridge or later Intel CPU, you should be good to go when it comes to getting the most out of the Oculus Rift.

THE REST

You don't want to cram in a load of high-end components only to let them be bottlenecked elsewhere in your PC, so you'll want to make sure that the other areas of your rig are up to the task. We recommend at least 8GB of RAM and, for future-proofing, we suggest going for a motherboard that can hold more than one GPU in SLI or Crossfire. Although multi-GPU setups won't be necessary for the Oculus Rift, it can give you a bit of leeway later on for upgrading your machine, though we recommend going for one powerful GPU, rather than two (or more) less beefy ones, simply because driver updates for multi-GPU setups can be sluggish.

You'll also want a decent PSU to power all of your components. Because you may well be running some pretty power-hungry bits of kit — especially if you're going to be using more than one GPU — you'll want a PSU that provides plenty of juice while remaining efficient. For this we recommend something such as the Corsair RM1000, which offers 1,000 watts of power while remaining 80 PLUS Gold Certified. It has a zero-rpm fan mode, which means the fan won't even start during low and medium loads, thanks to some cunning heat management of the PSU — so there won't be any annoying whirring noises while you're trying to immerse yourself in VR. Which is a nice touch.

VIRTUAL REALITY PERIPHERALS

BOOST YOUR OCULUS RIFT EXPERIENCE WITH THESE ADD-ONS.



VR HEADSET: OCULUS RIFT DK2

The consumer version of Oculus Rift isn't expected until some time next year, but if you can't wait until then, you can buy the Development Kit 2 version right now (the recently announced Crescent Bay version isn't available to buy yet). DK2 comes with a number of enhancements from the previous development kit, including positional tracking via a webcam for increased immersion — lean forward in your seat and the same movement will be transferred into your game. There's also a low persistence OLED display with improved resolution to reduce blur and motion sickness, and a built-in latency tester to help you calibrate the device for the best possible experience. It's available to order now from www.oculusvr.com/order for US\$350.



MOTION CONTROLS: RAZER HYDRA

Originally launched while the Nintendo Wii was at the height of its popularity, the Razer Hydra was pitched at bringing the then-popular motion controls to PC. Back then, this might not have been something many of us were asking for, but with the Oculus Rift, the Razer Hydra has seen something of a renaissance, with the combination of virtual reality and motion controls proving to be an irresistible combo. This new-found popularity has made the Razer Hydra somewhat difficult to track down, but it should be top of the list of potential peripherals to go with the Oculus Rift.

SOUND CARD: CREATIVE SOUND BLASTER ZXR

While buying a discrete sound card may seem like an archaic practice, it is probably worth considering if you want to create the most immersive Oculus Rift experience possible, because surround sound can really help place you right inside the game. While many motherboards these days come with onboard sound, they can only offer 7.1 surround through the analogue connections. For most of the time, if you want to use surround sound via an optical cable, which is the most popular method of connecting surround sound speakers and headphones, you'll probably need to invest in a separate sound card. For the ultimate sound quality and immersion, we recommend Creative's Sound Blaster ZxR. It's a little on the pricey side, but well worth the money considering the sound quality.

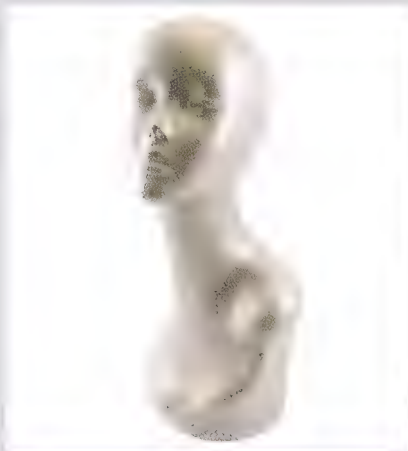
HEADPHONES: STEELSERIES H WIRELESS

Most of the time we'd recommend going for a full physical 5.1 speaker setup for the best surround sound experience rather than a headset that can only offer a simulation. However, with the Oculus Rift, where you're going to be moving your head, for the best immersive experience we recommend a wireless headset — and the Steelseries H fits the bill nicely. It offers excellent sound quality and very good virtual 7.1 surround sound — especially when paired with the Creative Sound Blaster ZxR sound card — which makes it possible to spatially pinpoint sounds in-game. It also comes with two swappable Li-ion battery packs and a charger built into the transmitter so you'll never be without juice.



STEERING WHEEL: LOGITECH G27

Racing and driving games are genres that really benefit from the Oculus Rift, with the rather sedate-sounding *Euro Truck Simulator 2* becoming a surprise hit thanks to the virtual reality experience. To get fully immersed, you'll want the best steering wheel money can buy — which the Logitech G27 currently is. With pedals, a gear stick and the ability to turn the wheel 2.5 times lock-to-lock, just like a real steering wheel, this is an excellent addition to the Oculus Rift. It also comes with force feedback for even greater immersion. The pedals sit in the nest of cables at your feet, and the wheel and stick clamp to your desk. Just be careful not to wrench them off during a particularly sharp turn.



HEADPHONE & OCULUS RIFT HOLDER: STANDARD MANNEQUIN HEAD

Okay, this one might not be the most obvious, but you're going to want a place to securely hold your Oculus Rift and headphones, so why not use something that will look pretty awesome next to your rig? You can buy standard mannequin heads from a number of online stores and it's a great way to make sure your Oculus Rift and headphones are kept safe and secure. It will certainly give your friends something to talk about when they come to visit. If keeping a head on your desk is a bit too creepy, there's a number of stylish headphone holders you can also use.



JOYSTICK: THRUSTMASTER HOTAS WARTHOG

You've probably guessed by now — thanks to our recommendations of getting top-of-the-range graphics cards and sound cards such as the Sound Blaster ZxR — that building the perfect setup for the Oculus Rift isn't going to be cheap. The Thrustmaster HOTAS Warthog might be pretty expensive (around \$550 for the joystick and throttle combo) but it is, in our not-so-humble opinion, currently the very best joystick on the market. Oculus Rift works best with games where you're sitting in a cockpit, such as flight simulators and space sims such as *Elite* — and a decent joystick can add even more immersion to your VR experience.

disc contents

» OUR SELECTION OF EXCLUSIVE FULL-VERSION PROGRAMS

ISSUE #10 CHRISTMAS 2014



Turbo-charge your browsing

Speed up your web experience with Ashampoo Internet Accelerator 3

FULL VERSION WORTH \$19

Ashampoo Internet Accelerator analyses your computer and optimises all the relevant settings with a single click. You don't need to know anything, just select the automatic optimiser and you're done. The new version also includes an internet connection speed test tool so you can test your performance directly. In addition to automatic optimisation advanced users can still access all the individual settings and adjust them manually.



Make your own web sites

Build your own web pages easily and quickly with Incomedia WebSite X5 Home 11

FULL VERSION WORTH \$24

Creating web sites with WebSite X5 Home 11 is Easy and Fun. Forget about technical hassles: you don't need to know how to program in HTML, all you need to know is what you want to create. And you'll be surprised at how quick it is to create your pages and get them online. Create professional-looking web sites thanks to the gallery of 250 ready-to-use graphic templates. Use the built-in graphic editors to customise the templates, modify pictures or set up new styles for the menus.



Optimise your PC's boot sequence

Streamline your system's startup with Abelssoft StartupStar 2014

FULL VERSION WORTH \$28

Did you know that an average PC has more than 20 different applications that are launched automatically when you start your PC? A lot of those startup entries are unnecessary and they usually slow down your PC's starting time. With Abelssoft StartupStar 2014 you've got full control over your PC's startup process, with the ability to enable, disable or delete programs in the startup.



Take control of your PC

Implement complex commands easily with 1-abc.net Settings Organizer 7

FULL VERSION WORTH \$21

Windows offers users a number of opportunities to customise their system, but unfortunately, most of these features are not available through the control panel and can only be configured by modifying the main Windows settings database which is called the Windows Registry. Since this procedure is only suggested for advanced users and should only be done with the highest caution, 1-abc.net Settings Organizer offers many of these options in a small and easy-to-use program so that even beginners can configure their system to let it behave the way they want.

SYSTEM REQUIREMENTS

- A DVD-ROM reader or burner.
- The APC disc is designed for use with up-to-date browsers (for example, Internet Explorer, Chrome, Firefox).
- The interface included on the APC disc requires a JavaScript-enabled browser.
- An internet connection may be required for online registration of software before use.
- The software packages on the APC disc have different system requirements. Software is included on the disc for Windows Vista, 7 and 8.

BEFORE INSTALLING

- Check the disc using a virus scanner complete with the latest antivirus data updates. The disc was checked before burning, but new viruses are being discovered all the time.
- Back up any important system and data files. It is not recommended that the software contained on these discs be installed on production machines.
- If you have any questions regarding the use of the APC disc, click the 'Help' button at the top of the screen.

USING THE DISC

- Insert the disc into a CD/DVD-ROM reader or burner and your web browser should automatically load the interface. If not, launch your web browser and load the default.html file from the root directory of the disc.

HELP

- If you have any problems with the APC disc, please visit www.apcmag.com/disc.htm.
- APC provides no technical support for this disc or any software provided on it.

NO DISC?

Please note the free cover disc is not included with digital editions or bundled promotional copies of APC.

PLUS! CAVE STORY FULL GAME & GRAPHIC DESIGN ESSENTIALS TOOLKIT

DISCLAIMER Future Publishing is not the licensor of the software and documentation on the enclosed disc (the 'software'). Rather, Future is merely a distributor of the software, and your use of the software is subject to any accompanying third party licence terms. You must carefully read and comply with any such third party licence terms, together with all instructions and README files that come with the software. Accordingly, to the maximum extent permitted by law, all software is provided by Future 'as is' and without warranty either express or implied, and Future will not be liable for any damage that you may incur as a result of using the enclosed disc. You should back up any important system and data files before using the enclosed disc. We recommend that you do not use the enclosed disc on a production machine. Nothing in this disclaimer excludes any warranty that may be implied by statute, which may include the Trade Practices Act. Notwithstanding the foregoing, if the enclosed disc is faulty or damaged, we will replace them for you. While we have taken all reasonable steps to check the enclosed disc for viruses, we cannot guarantee that it is free from viruses or other harmful code and you should check each disc using a virus scanner complete with the latest antivirus updates before use.

BUILD A MEDIA PC WITH YOUR PI

Turn your Raspberry Pi into a dedicated home theatre.

One of the coolest things you can do with a Raspberry Pi is use it to power your home theatre. It really doesn't make sense to spend dough on a dedicated HTPC device, when you can put one together in no time and practically for free. Yup, just like the spare hardware, the software that powers the HTPC won't disturb your accounting books.

The OpenELEC project produces a distribution to help transform your computer into a media centre. It's powered by the XBMC Media Center application, which is an open source environment that can play all sorts of media including movies, music, pictures and more. It's designed to feel at home on a desktop monitor as well as a high-definition TV or even a wall-mounted projector.

While you can install XBMC on top of another OS such as Windows or Linux, the advantage with OpenELEC is that you get a streamlined distribution designed from scratch for one purpose only. Also, you can use OpenELEC without any knowledge of its base Linux OS.

GET OPENELEC

OpenELEC doesn't put a strain on precious hardware resources, so you can run it on older under-powered systems with less memory and a slower processor. It can perform on dated hardware because the project has several releases optimised for different platforms, such as the Nvidia ION, Apple TV, AMD Fusion and even the Raspberry Pi. For this tutorial, we'll use the catch-all build which will work on any x86 Pentium 4 and newer computer. Head to the OpenELEC Download page (openelec.tv/get-openelec) and grab the stable Generic build (openelec.tv/get-openelec/viewcategory/8-generic-builds) for your architecture (32-bit or 64-bit). For installing on the Raspberry Pi, you'll need to use the stable Raspberry Pi ARM version from (openelec.tv/get-openelec/viewcategory/10-raspberry-pi-builds).

Once you have downloaded the file, you have to create a bootable USB drive with the file, which you'll then use to install OpenELEC on to the computer.

Fire up a terminal and change to the directory where you have downloaded the OpenELEC file. Extract the contents of the .tar file with the command `tar`

`xvf OpenELEC-Generic*`. For the Raspberry Pi use the command `tar xvf OpenELEC-RPi*`. This creates a folder with all the extracted files in it, such as `OpenELEC-RPi.arm-3.2.4`.

Now plug in the empty USB drive and find out its mount point by using the `sudo parted -l` command in a terminal. The command lists all the disks attached to your computer, including the hard disk.

You should see your USB device listed as `/dev/sdX`, such as `/dev/sdb` or `/dev/sdc`. Please double-check the address of the USB device, otherwise you'll rewrite the contents of the wrong disk.

Once you're positive about the location of the USB drive, change to the directory in which you have extracted the files and write them to the USB disk with the `create_livestick` script, such as `sudo ./create_livestick /dev/sdX`. Don't forget to substitute `/dev/sdX` with the actual location of your USB disk.

The script then launches the OpenELEC USB installer, which formats the USB disk and copies files to it. When it's done, you can unplug the USB drive and move to the computer you wish to turn into the HTPC.

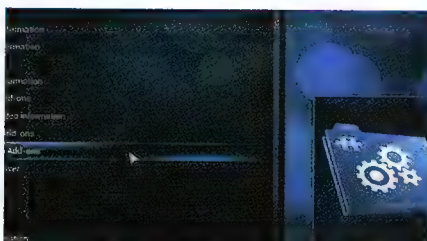
Plug in the USB disk and boot the HTPC.

How to install add-ons



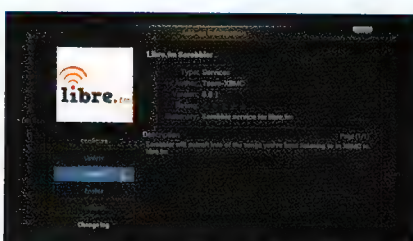
1 UPDATE

You can extend your HTPC by adding new features via plug-ins. Make sure you are connected to the internet and then go to 'System > Settings > Add-ons > Get Add-ons'. Right-click on any enabled add-on source and select the 'Check for updates' option.



2 BROWSE

Repeat this process for both enabled add-on sources. Now select the 'All Add-ons' option to browse the list of add-ons from both repositories. The add-ons are listed under different categories, such as Music Add-ons, Program Add-ons and so on.



3 INSTALL

When you find an add-on you like, click on it to bring up its information screen. From here you can get several options, including the option to install the add-on. You can also update an already installed add-on and configure any available options.

Remote-control XBMC

Once you have your HTPC up and running, it's best to disconnect all the peripherals, such as the keyboard and mouse, and hook it up with your HDTV or projector. As long as it's connected to the network via a wireless adaptor or an Ethernet cable, you can access and control it remotely.

OpenELEC runs the Samba service by default, so it's listed like any other network location under a Windows, Linux or Mac computer on the network.

Furthermore, you can also control playback remotely from either a web browser or a mobile app. For this to work, make sure you've enabled the following settings under 'System > Settings > Services in OpenELEC'. In the 'Remote control' section, make sure the 'Allow programs on other systems to control XBMC' option is enabled. Then switch to the 'Webserver' section and enable the 'Allow control of XBMC via HTTP' option, and set a username and password to restrict access to your HTPC.

Now fire up a web browser and enter the IP address of your HTPC, such as <http://192.168.2.111> which brings up the default web interface. You can also install additional interfaces as XBMC add-ons. All installed web interfaces are available under the addons/ directory under your HTPC's IP address, such as <http://192.168.2.111/addons>.

You can also control the HTPC by downloading an XBMC remote-control app on your smartphone. Then point it to your HTPC's IP address, equip it with your log-in credentials and you'll be able to control OpenELEC from your smartphone.

You're greeted by the OpenELEC installation screen, which gives you two options. The option selected by default enables you to run OpenELEC in Live mode. The other option launches the installer to install OpenELEC on the hard disk attached to the HTPC. Highlight this option and then hit the Return key to continue.

The first screen of the OpenELEC installer warns you about the beta nature of the installer before moving on to the main installation menu. Here you get different options. Some options, such as the 'Setup OpenELEC' option, are still under development and haven't been implemented.

In fact, the only option that works flawlessly also happens to be the one we are interested in — the 'Quick Install' option listed at the very top. This option automatically installs OpenELEC on a selected hard disk.

After you select the 'Quick Install' option, you're shown a list of hard disks attached to the computer. Select the hard

disk you wish to install OpenELEC on. Over the next few minutes, the installer wipes the disk, formats a partition for OpenELEC, and copies the necessary files to transform the computer into an HTPC.

Once it's finished, you're returned to the main menu. Simply select the Reboot option and you're done. When the computer restarts, it boots straight into OpenELEC and launches XBMC.

USING OPENELEC

Before you can use the XBMC media centre, you'll probably need to configure some settings, such as connecting the HTPC to your network. OpenELEC takes you through all the important settings as soon as you boot into a fresh install.

On the first screen of the four-step set-up wizard, you're asked to select your regional settings, including your language and keyboard layout. In the next screen you have to pick a hostname, which is used to identify the HTPC on your local network, and also for configuring various network services, such as Samba file

sharing. By default, the setup uses the 'OpenELEC' hostname.

Next you are shown a list of available network connections, including Wi-Fi access points. To connect to one, select the network from the list and enter its password when prompted. After OpenELEC has connected to your router, it displays the IP address assigned to it.

The last step involves enabling and disabling services for file sharing and remote access. By default, OpenELEC has enabled the Samba file sharing services, which allow you to access the hard disk on the HTPC from any computer on the network. This is useful for moving media files around.

If you are an advanced network user, you can also enable SSH access from this screen to access your files securely. The default username of the HTPC is 'root' and the default password is 'openelec'.

That's all there is to it. You can now pull out the keyboard and the mouse, plug in the high-definition TV, and start using your HTPC to play any media.

Apps



1. Official XBMC Remote

Team-XBMC

★★★★★

✓ INSTALLED



2. Yatse, the XBMC Remote

Tolriq

★★★★★

FREE



3. XBMC remote control

Georgoud

★★★★★

FREE



4. Music Pump XBMC Remote

Android Music Pump

★★★★★

FREE



5. XBMC / Boxee Remote

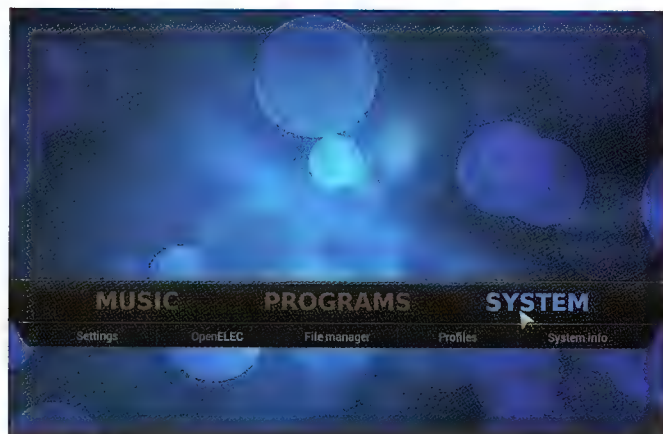
Chandan Pitta

★★★★★

The Google Play Store hosts several XBMC remote apps.

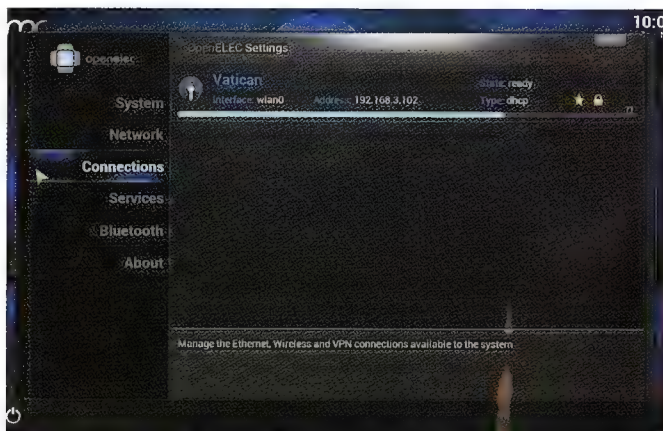
Set up OpenELEC

Keep your HTPC in top condition.



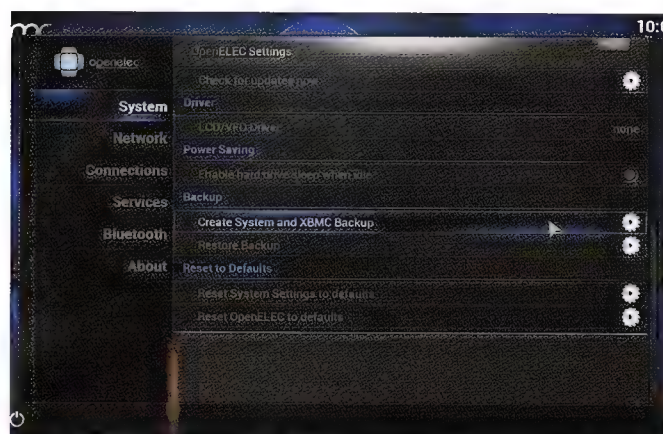
1 EXPLORE SYSTEM SETTINGS

In addition to the expansive XBMC settings, OpenELEC includes some settings of its own to help you maintain your HTPC. You can find these settings by heading to 'System > OpenELEC'. The settings are divided into different groups that enable you to manage different aspects of the HTPC.



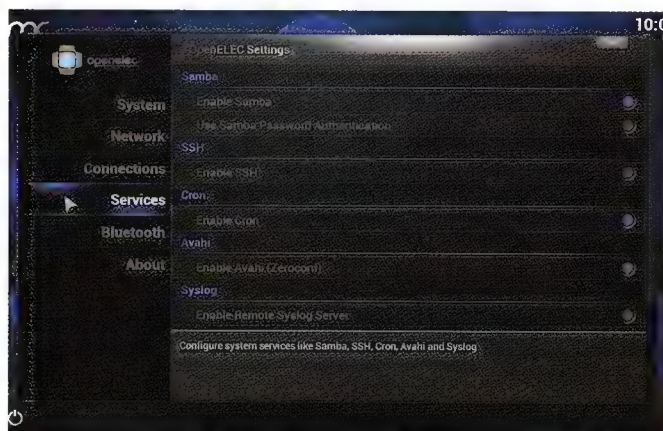
3 NETWORK AND CONNECTIONS

From the Network section, you can activate both wireless and wired Ethernet connections, and configure VPN connections and network mount points. This section also lists the NTP servers. Head into the Connection section if you want to manage the activated network and any VPN connections.



2 UPDATE AND BACK UP

From the System section you can alter the hostname and keyboard layout that you set in the first-time wizard. You can also check for updates to the OpenELEC platform, as well as create a backup of the HTPC. You can also enable a power-saving feature and reset to the default settings.



4 ENABLE SERVICES

OpenELEC supports a number of different network services, such as SSH, Avahi and so on, and you can activate them from under the Services section. By default, the Samba, Cron and Avahi services are enabled. To enable a service, all you need to do is click on the relevant name.

Raspberry Pi as a media centre

Believe it or not, the puny 700MHz Raspberry Pi can double up as a very capable home theatre PC. Not only is the Raspberry Pi capable of displaying video at full 1,920 x 1,080 resolution, but thanks to the sound interleave of HDMI, it can also play back audio on the same channel as video.

While you can install XBMC on top of the Raspbian distro for the RPi, there are in fact several projects that are working to produce a dedicated media centre distro for the RPi. The OpenELEC distro we're using for this tutorial is arguably the most popular; there're also a full x86/x64 versions of OpenELEC available if you'd like to use it on a more powerful PC, such as an Intel NUC.

If you're looking for other Raspberry Pi compatible options,

another popular Pi media centre distro is Raspbmc, which can be found at www.raspbmc.com.

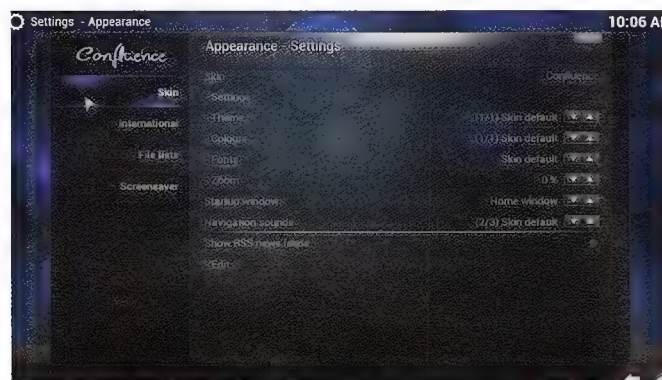


Configure XBMC

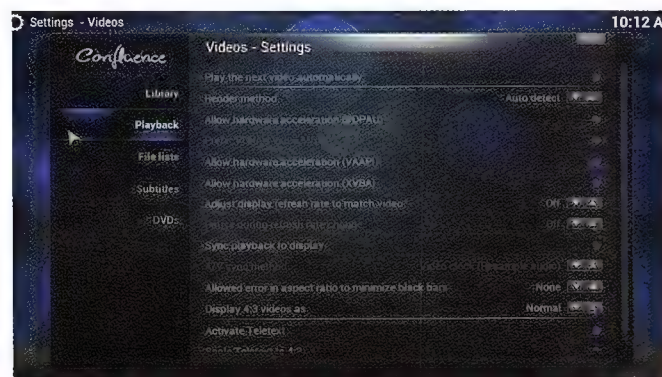
Take charge of the XBMC media centre.



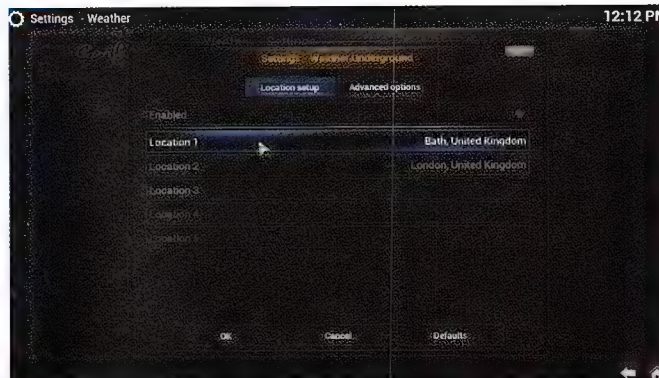
1 REVIEW SYSTEM INFORMATION
XBMC ships with lots of options to let you control various aspects of your HTPC. You'll find them all under 'System > Settings'. For starters, you can take stock of the hardware by heading to the System section, which has detailed information on how the resources — including the CPU, memory and disks — are being utilised.



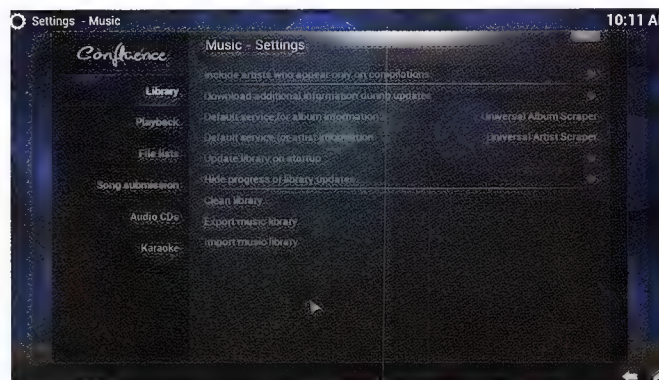
3 CHANGE APPEARANCE
Make your way to the Appearance section to customise the look of your HTPC. The section hosts settings to alter the various elements that make up a theme and even lets you download new skins. You can also tweak the behaviour of the screensaver, the language of the interface, and formats for settings such as date and time.



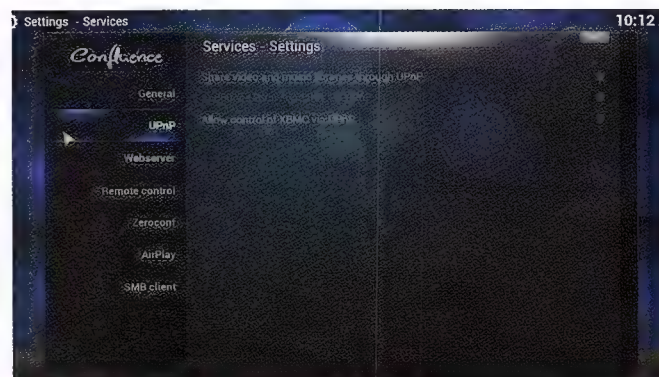
5 VIDEO SETTINGS
Similarly you can set several video playback-related options from under the Videos section. So you can ask XBMC to fetch plot info for media that you haven't watched, get thumbnails for actors when scanning media, and try to sync audio and video. You also get options to configure how XBMC renders subtitles.



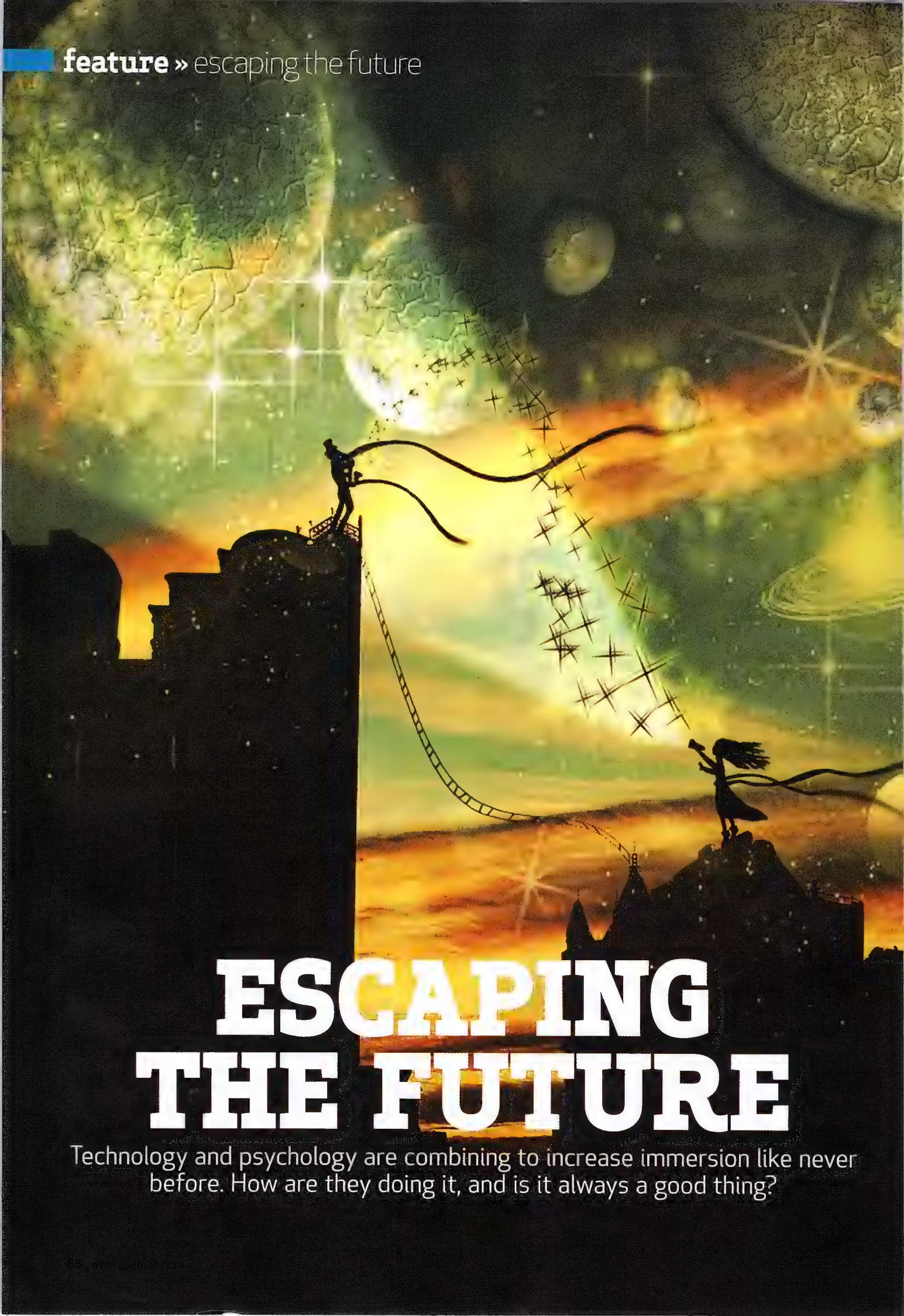
2 CONFIGURE LOCATION
Next head to the Weather section to configure your location. XBMC can track weather information for multiple destinations and can fetch this information from several websites, including Weather Underground and Yahoo! weather. The section has options to set up your location and switch to a different forecasting service.



4 MUSIC SETTINGS
From the Music section you can alter the behaviour of how XBMC reads the tag information from the music files and uses it to display your library. You can also adjust the playback settings such as crossfade settings between songs, select visualisations, and submit songs to online services such as Last.fm and Libre.fm.



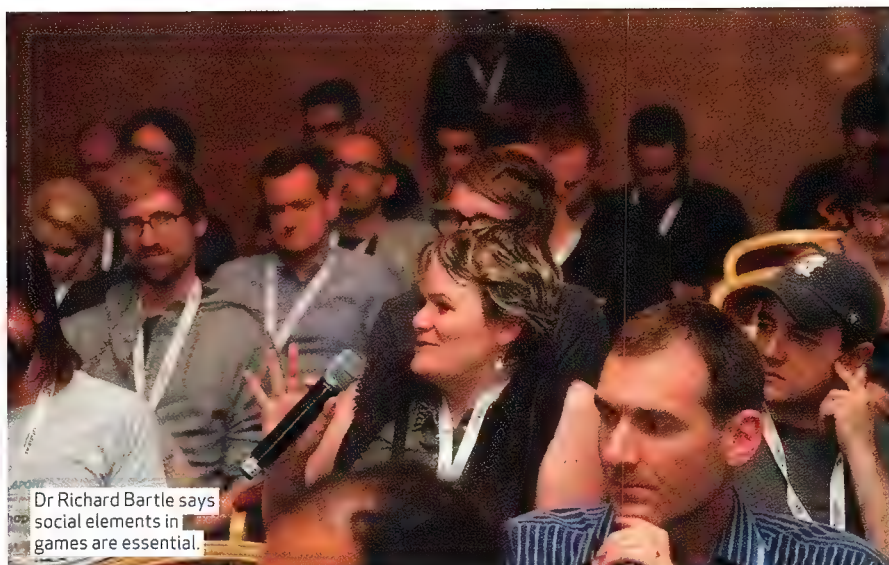
6 ENABLE SERVICES
The Services section has some interesting network services. Here you can enable the UPnP server to stream media and allow XBMC to play content received via AirPlay. You can also allow remote control of your HTPC by enabling a web server and controlling playback via one of several available web interfaces.



feature » escaping the future

ESCAPING THE FUTURE

Technology and psychology are combining to increase immersion like never before. How are they doing it, and is it always a good thing?



Dr Richard Bartle says social elements in games are essential.

What is escapism? It's a step away from the pressures of the world that diverts you from the tedium and unpleasantness of everyday life. It also has a negative side when taken to an extreme. In this sense, the escapist is escaping too much. Whether they're unable or unwilling to cope with the pressures they're facing, ignoring them actually makes them worse.

Whether positive or negative, escapism can take many forms. A hot bath. A meditative retreat. A country walk. Watching the sunset over Machu Picchu. A holiday to a country where everything is cheap. Increasingly, though, it's technological. I live in London, but I've been to packed cities all around the world. On those few occasions that I'm forced onto a train, I see a fascinating social experiment. The train at rush hour is a high-



Escapism is serious business for the creators of mobile game Rival Knights.

"Yet the core technology that's most useful for escapism now is virtual reality (VR)."

pressure environment; it's often too hot, crowded, smelly, bumpy and rapidly-changing to be comfortable. In this high-stress situation, people around the world react in different ways. In Japan, for example, many people fall asleep (or pretend to). They'll do this standing up, alone among strangers, for two or three stops. In Paris, rudeness ramps up to such a degree that the Metro company has issued a special book of tongue-in-cheek etiquette (tinyurl.com/od9gwtf). In almost all major cities, people plug into their smartphones and play apps or music, or read on Kindles, and pretend the rest of the passengers don't exist.

So how is technology aiding escapism? How do psychologists think that escapism is going to change? Are the simulations we currently call

games the perfect escapist tools, or do they add to the problem?

So we're talking escapism, and how technology and gaming can augment people's ability to get away from the troubles of the world in a healthy manner. Many mature technologies are already contributing to this immersion — high-resolution screens, surround-sound systems, well-designed user interfaces, touchscreens, motion sensors, haptic feedback and so on. We can now touch, see, hear and feel a photorealistic world.

Yet the core technology that's most useful for escapism now is virtual reality (VR). We've talked about this extensively in the past, but it's worth emphasising that modern forms work even better than the best 3D cinema. As psychologist Jamie



Berni Good is an expert on the connection between psychology and gaming.

Madigan told me, "Having a setup that allows you to forget about the technology between you and the game world is what spatial presence is all about, and from what I understand VR setups do that very easily. In many ways, they trick our brain at the same level that reality does."

In previous issues we've talked about the Oculus Rift VR headset, which Facebook bought for \$2 billion in March this year. The Rift hasn't reached a consumer-ready stage

(though Mark Zuckerberg has said that he wants to sell it as cheaply as possible), but the latest development kit (DK2) is much higher resolution than the previous iteration, and is being delivered to developers now.

I attended the Develop Conference in Brighton to ask questions about virtual escapism and to get my hands (and eyes) on the Rift's first real competitor, Sony's Project Morpheus.

4, its motion-sensitive Move controllers and its camera. By targeting the PS4 instead of the PC, Sony has sacrificed raw power for standardised hardware and a living room experience. The only flaw is that Morpheus currently uses LCD screens instead of the Rift's superior OLED. Yet both headsets are prototypes, and the ultimate goal for Oculus and Sony is a wireless, lightweight headset no larger

whole of society," explains Liquid Flower Games' music composer Joost Kraaijenbrink. "Of course, physically speaking, we're already gaming pretty much everywhere. We all have handhelds, or at least games on our phones, so for most of us, wherever we go, we can play games." But it's not just hardware – it's about software in everything we experience, and all software having game-like elements.

"Both headsets are prototypes, and the ultimate goal for Oculus and Sony is a wireless, lightweight headset."

It's a convincing challenger, and one of its strongest features is its ergonomic design. Though the Oculus Rift has improved substantially since the first time I used it, it's still an awkward piece of kit. It has straps and weights in strange places, making it a real workout for your neck. By contrast, Sony has used its experience in product design and outsourced all the Morpheus's non-screen hardware to a small desktop box. This has resulted in a lighter headset with the same power and resolution as the Rift.

Sony has also focused on making the kit work natively with the PlayStation

than a set of ski goggles. Whatever the hardware, given its established audience and the competition in the console market, the Morpheus is looking more plausible as an early VR success than the Rift – the VHS to Oculus's Betamax, perhaps.

But what do you experience on these devices? As gaming has expanded, it's becoming increasingly hard to speculate about where it's going. The simple answer would be 'everywhere'.

"The combination of evolving technology and ubiquitous experimentation might well lead to games being pervasive throughout the

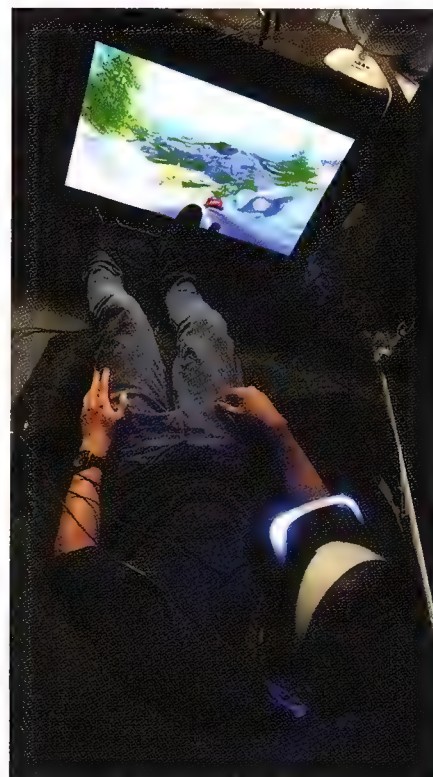
USING IMMERSION

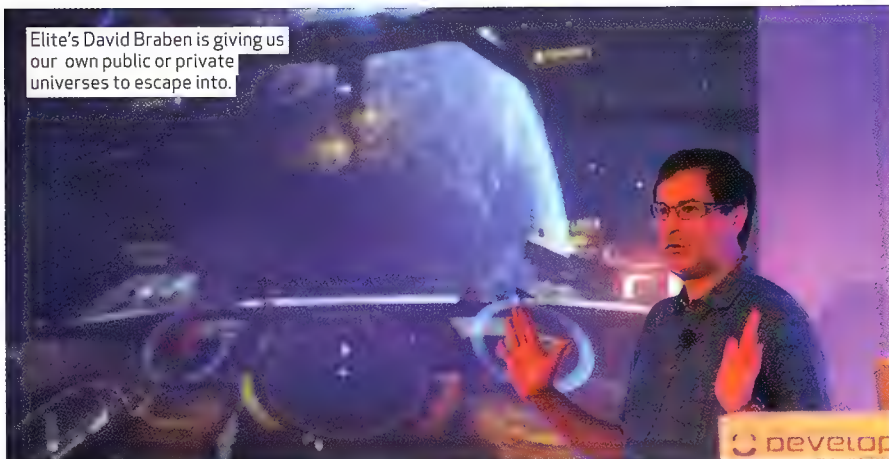
Technology isn't the only thing that leads to immersion; it's also how developers use it. Away from the Project Morpheus demos at the Develop conference, Patrick O'Luanaigh of game developer nDreams offered practical tips to developers wanting to maintain immersion. He explained that players want to stay immersed, so the developer's aim is to maintain the illusion – by keeping movements smooth, avoiding the uncanny valley and keeping everything's speed realistic, for example. Controls are equally important. Players can't see a controller, so developers might forgo the WASD keys for the easier-to-find arrow keys. For example, in *Call of Duty* your characters walk and sprint faster than the average human, and turn faster too, so it feels unnatural in VR.

Even in games whose settings are seemingly otherworldly or alien, the same rules apply. Freelance game developer and designer Kerry Turner is just finishing work on Heartwood (www.heartwoodgame.com), a VR



Sony's Project Morpheus headset will bring virtual reality to console owners.





simulation of a strange woodland. Despite its whimsical premise, she focused on keeping it realistic. "I want, as much as possible, for the player to feel like themselves in a strange place," she explained. "With that in mind, I think that tropes that suggest everyday reality – gravity feeling 'right', head movement when walking, that sort of thing – have an important part to play in the effect I'm trying to achieve. Having said that, I don't think they're important in all fantastical games. I think that the real key to immersion is consistency – not necessarily consistency with reality, but just an internal consistency that lets you experience that sense of presence."

Berni Good is the founder of Cyberpsychologist Limited, and consults on the intersection of psychology and gaming. She says that although developers have worked out some guidelines themselves, there are psychological tricks and problems they have yet to discover. After all, current VR technology is analogous to the black and white era of movies.

The first simple trick she points to is maintaining the player's sense of competence, whatever they're doing. "(This) is a key psychological intrinsic need as discussed and researched within a psychological theory called Self Determination, first postulated by

Deci & Ryan (1985)," she says. Given the clumsiness of players in a game relative to their expectation of their own capability, ensuring competence is harder than it sounds. The Morpheus shark attack demo I played failed to maintain competence, as the player was given a flare gun that fired flares that did absolutely nothing. Patrick O'Luanaigh's talk even suggested dispensing with the perception of your own body completely, because to make a believable body that matched every player's expectations – colour, size, reactivity, texture, shape, detail – is nearly impossible.

This ties in with a sense of maintaining 'flow', which Dr Linda Kaye of Edge Hill University addressed at the conference. It's described as a state of energised focus, full involvement and enjoyment. In games, flow is all about keeping a player absorbed and keeping them coming back. By balancing a game effectively against a player's skill so that they don't find it too hard or too easy, you can keep them in a flow state, even as part of a group of online players. As Berni Good puts it, "Developers can enhance flow by focusing more on the cognitive features in gameplay such as challenge, concentration, goals and feedback."

Similarly, interactions with uncanny characters can bounce players straight

Psychology and game design

Other ways for game designers to address psychological problems.

Jamie Madigan has a PhD in psychology and writes a blog about the psychology of gaming at www.psychologyofgames.com. He's impressed by the way designers use psychological studies. "You've got the guys at Riot using psychology to reduce toxic behaviour in *League of Legends*, for example, by controlling how social situations are constructed within the game and providing players with different kinds of feedback about their behaviour," he says. "It's basic social psychology stuff, and it seems to be working. Other companies employ psychologists in their user interface design groups, and in playtesting. Anything that requires measurement of human behaviours and attitudes could benefit from the involvement of a psychologist."

However, he's also cautious about the degree to which the research itself is biased towards politically popular topics rather than practical learning. A lot of the psychological research now focuses on violence in games, games addiction and using games in education. "Those are fine research topics," says Madigan, "but I would love to see more psychologists addressing more nuts-and-bolts features of game design. What is the best way to provide players with feedback about their progression through a game? What kinds of interactions do they want (and have) with other players? How can you best present comparisons with other players to best motivate players to keep playing and improving? And, of course, how do you curb antisocial behaviour?"

Still, he believes the future for psychology and games is bright. "I want to see classes in media psychology and video game psychology taught as part of psychology programs and game design programs," he says.





An escapist's education

Can escapist games be used to improve learning in schools?

Education, you might think, is exactly the opposite of escapism. After all, the traditional school environment, as depicted by Dickens in *Nicholas Nickleby* and Thomas Hughes in *Tom Brown's Schooldays*, was a fairly brutal institution — precisely the thing a child would want to escape from. Yet, as Liquid Flower's composer Joost Kraaijenbrink points out, it has the potential to benefit greatly from gamifying and immersion. "One learns best by doing, and the interactivity in games allow for a much more 'doing' approach than any other medium, without actually needing the resources (or risks) to do whatever you want to teach for real. Think simulators, not just for things like airplanes or cars, but also perhaps surgeons, architects, management and so on."

Beyond the egalitarian benefits of letting anyone experience any job through simulators, which is still some way off, education could still benefit from the enthusiasm and reduction in stress that come with 'non-achiever' gameplay. After all, immersed, engaged and relaxed children are receptive children.

At the Develop Conference, Ian Livingstone (former life president of Eidos, founder of Games Workshop, co-creator of *Fighting Fantasy* and the new UK Creative Industries champion) explained how he thought education should change. "In schools today, we focus too much on the computational nature rather than the how, when and the why," he said.

As well as pushing immersive education, he wants to teach coding as a tool for creativity, and to gamify education, so that pupils learn the important life skills that are inherent in many games rather than plain academic facts which are of minimal use after school life. He also claimed that peer-to-peer learning improves pupil performance by 30%. When it comes to escapism and immersion in education, there's definitely some room for further studies.



out of their sense of immersion. The concept of the uncanny valley was first created by the robotics professor Masahiro Mori in 1970, and it's swiftly reached the same state in games as it has in robotics — if a character isn't utterly convincing, it's oddly off-putting and jarring. In terms of game design, it's often better to create something deliberately inhuman than something that only just fails to be human as the eye is more critical of the latter and tars it with the brush of psychopathy. This can be a real problem if the developer intended that character to be sympathetic.

It's also worth keeping social elements alongside the challenges in your games. Dr Richard Bartle (co-creator of the first MUD) split gamers into the four categories of explorer, socialiser, killer and achiever. These categories were fairly arbitrary, but have held up well as a sociology of gamers and those socialisers need some social elements to play with — even if they're only NPCs who make a little quip every time they sell the player a health potion.

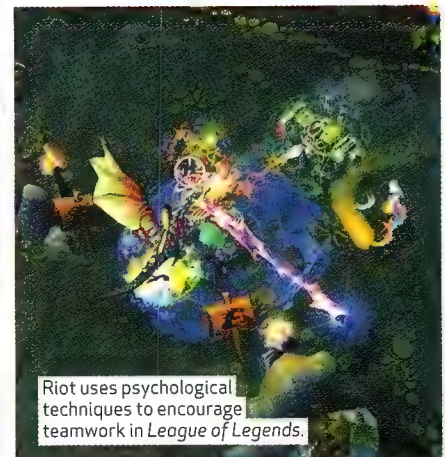
And, of course, the experts at the conference warned against using the cynical compulsion loops employed by free-to-play game developers everywhere — despite the way they can increase 'flow' — because the player is bounced right out when the game asks for payment at a critical moment. "Some of the consumer psychology around this area sadly is being used by some developers to 'trick' the gamer into paying more out," says Berni Good. "They know who they are, and frankly it's not ethical. Enough said."

She suggests that in order to achieve deeper immersion, VR needs to advance from its current state as a purely visual medium. "Enhancing presence will be key to the future success of psychology and video games. I would suggest that games will have built into them ways to dynamically feedback and change the direction of the game for each specific player by using tools such as advanced brain monitoring or other psycho-physiological and psychological tools," she explains. "I see a focus on presence to get to the point whereby the presence in 3D worlds will feel the same in a virtual world as in the real world."

Again, this may be a few years down the line, but who knows where we'll all be when the wearable technology revolution really takes off? It's not inconceivable that VR games will be able to interact with the wearables you own, and any residual RFID tags in the area.

ESCAPISM AS ADDICTION

Escapist games take all forms. Much escapism is helpful — giving you time to think about problems or allow wounds to heal — but it's not always positive. The Norwegian psychologist Frode Stenseng has argued that the flow state praised by Dr Kaye and Berni Good resembles the focused condition seen in obsessions and addictions. He says flow can develop either harmoniously or obsessively, and all of the above techniques could be negative for someone who's coming to their gaming in a poor mental state. The jury, after



all, is still out on whether problematic gaming is actually gaming addiction.

Philippa Warr is a journalist and writer, working for publications including the *Guardian* and *Wired*. She's quite candid about the fact that she has had a problem with gaming — specifically with Valve's *Dota*, a multiplayer arena combat game. As the psychologists indicated above, she uses the games as a method of relaxing and stepping away from her problems. The problem isn't the gaming, which is reassuring; it's that it's not helping with her problems.

Warr's Steam profile reveals that she has spent nearly 1,500 hours playing the game. "Sometimes you need to be able to occupy your mind with something other than what's bothering you," she says. "Games can do that, especially ones like *Dota* where there is so much to learn but you do so through a rhythmic match setup. It's comforting because of the repetition of the map and the basic phases of the game but stimulating because of the variety within that."

However, at some point her *Dota* gaming turned from a positive comfort into a place to avoid her problems. "I realised that I was only feeling better while playing and as soon as I logged out that feeling would evaporate. It

wasn't having a knock-on positive effect on the other situation, even just in terms of offering a bit of respite and letting you come back a bit refreshed. That was the point at which I felt like I was hiding and that it was a negative thing. I wasn't even enjoying the game, exactly. I was just enjoying not having to deal with depression for an hour at a time, or feeling like I was socialising without having to actually talk about anything."

Professor Jeffrey Snodgrass of Colorado State University explored this contradiction in a 2014 paper called *Motivated MMO Play and the Pleasures and Perils of Online Experience*. He found some interesting distinctions in how players reacted depending on how they played a sample game — the ubiquitous MMO *World of Warcraft*: "The authors find that playing to achieve is strongly associated with distressful play; results that support findings from other studies. By contrast, social and immersion play lead more typically to positive gaming experiences, conclusions diverging from those frequently reported in the literature."

Berni Good explains that the study also seems to show that less stressed individuals benefit more easily from the relaxation offered by games, while

individuals bringing stress into the game don't get the relief they seek.

That tallies with Warr's *Dota* experience, where she felt the social side of the game had become token, secondary to a very strongly-achievement oriented competitive culture, which failed to dissipate the stress and depression she was feeling during her actual day-to-day life. In my opinion, the contrast between the simple drive to achievement and regularity of success in the game, compared to the difficulty and complexity of achieving anything noteworthy in real life feels like a reason for depression — and another reason for seeking escapism.

Technology is mediating our contact with the outside world, and allowing us to contact each other's private worlds more and more easily. Imagine everyone you might see on the train today, locked away in their heads, sleeping while standing or playing games on their phones. Now imagine stepping into the same scene, but everyone is wearing VR sunglasses and playing games entirely by themselves, heads bobbing and mouths moving in a hundred cross-cutting fantastical dialogues. It's an alien world, but it may be coming. And it won't be good for everyone. ■

CRYPTOGRAPHY: OLD AND NEW

Join Jonni Bidwell on a journey of code-making and -breaking, mystery and intrigue...

For as long as there have been stories there have been secrets – words unspoken for tactical advantage or for fear of reprisal.

Secrets often need to be sent afar, and their remaining secret en route is of paramount importance. So it was when Xerxes' attack on Sparta was thwarted by Demaratus (a Greek exile living in Persia, whose warning message was sent to Sparta hidden on an apparently blank wax tablet). And so it is when you send your credit card details across the ether to pay for gadgets, snacks or socks.

Most people will likely be familiar with a substitution cipher, in which one letter is replaced by another. The best-known of these is the Caesar cipher, in which each letter is replaced by one a fixed distance further down the alphabet, wrapping around when one runs out of letters. It is said that Julius Caesar used this method, replacing A with D, B with E, and so on, wrapping around with A replacing X, whereas his nephew Augustus favoured a shift of just one letter, in which A is replaced by B, B by C etc, but with no wraparound, so that Z is replaced by the symbol AA.

The Kama Sutra also describes, among other rather more interesting tricks, the art of *mlecchita-vikalpa* (secret writing). It details a substitution cipher in which letters are paired and interchanged by a fixed random scheme, so that lovers can "conceal the details of their liaisons". An even older substitution system is Atbash, originally found in old (circa

500 BC) Hebrew texts. Here the first letter of the alphabet, aleph, is replaced by the last, tav; the second, beth, by the second to last, shin, and so on, effectively reversing the alphabet. The latinic equivalent is interchanging A and Z, B and Y, and so forth. The ROT13 system (a Caesar cipher with a shift of 13) is still used on some web sites and newsgroups to obfuscate plot spoilers, punchlines or naughty words.

These monoalphabetic substitution ciphers (MSCs) are not in any way cryptographically secure by today's standards, but in their time they were likely effective enough – the highway bandits of Caesar's time being likely illiterate, unlike the masterful wordsmiths of the modern internet. These ciphers do contain a germ of the idea of the modern cryptographic key, though. Whether it's the length of the shift in a Caesar cipher, the dimensions of the Scytale, or the pairings used in the Kama Sutra (no, not those pairings), knowledge of the method of encryption, together with the key, allows one to decipher the message.

We have 26 possible keys (including the trivial zero-shift) for a Caesar cipher, whereas ROT13 and Atbash are essentially single-key systems. The Kama Sutra cipher has a fairly large keyspace – there are about 8 trillion (8 followed by 12 zeroes) unique ways of pairing the alphabet. The general MSC has an astounding number of possible combinations (26 factorial – about 4 followed by 26 zeroes – or a little more than 88-bits in modern binary terms), but size isn't everything. The Arab polymath Al-Kindi, in a ninth-century

manuscript titled 'On Deciphering Cryptographic Messages', gave the first description of breaking MSCs by frequency analysis – exploiting the fact that in an 'average' message, some letters will occur more frequently than others.

For example, in English the letter 'e' occurs with a relative frequency of about 13%, followed by 't' with 9%, and so on. This is why Scrabble scoring is the way it is – the more common the letter, the less it scores. Other languages have different letters and frequencies, but the principle remains the same: replace the most frequently occurring letter in the ciphertext with the most frequently occurring letter in the language, then repeat for the next most frequent letter, and continue until you are able to fill in the blanks. The original message might not have exactly the same letter frequencies as the language, but provided it's long enough it will at least be close enough that decryption will be possible with a little tweaking.

The discovery of the 1586 Babington Plot (which sought to assassinate Queen Elizabeth I) led to Mary Queen of Scots and her co-conspirators being executed after their correspondence was decrypted by renowned codebreaker Thomas Phelippes. Letters between Mary and Babington had been encrypted by substitution using symbols mostly from the Greek alphabet, and Phelippes was able to forge an addendum to one of Mary's letters requesting the identities of the co-conspirators. Once they were thus incriminated, heads were off'd.

A milestone in the history of cryptography was the invention of the so-called Vigenère cipher in 1553. This was actually the work of cryptologist Giovan Battista Bellaso, who built on the ideas of Trithemius and Alberti. Vigenère did in fact publish a stronger autokeying cipher in 1586, but history has misattributed this earlier cipher to him. The cipher is a polyalphabetic substitution cipher which uses a keyword to switch cipher alphabets after each letter. Each letter is encrypted by a Caesar cipher with shift determined by the corresponding letter of the keyword. This (providing the keyword has more than one unique letter) thwarts traditional frequency analysis. The cipher was considered so strong that it was dubbed le chiffrage indéchiffrable, and indecipherable it remained until work by Babbage and Kasiski in the mid-19th century. Their efforts centred on isolating the length of the key: once that is known then the ciphertext can be separated into as many chunks; each chunk will be encrypted by a different Caesar shift, which is easily dealt to by frequency analysis.

Later, this cipher was augmented with the letter V to make the imaginatively-titled ADFGVX cipher. In 1918, in a phenomenal tour-de-force, the French cryptanalyst Georges Painvin managed to decrypt an ADFGVX-encrypted message which revealed where the German forces were planning to attack Paris. Painvin lost 15kg of body weight over the course of this crypto-toil.

One may wonder if anyone can make

a truly unbreakable cipher, and one may be shocked to learn that such a thing already exists. That it has been patented since 1917 may leave one so utterly aghast as to impinge permanently on one's health, but this is fact nonetheless. The chap responsible (for the patent at least) was Gilbert Vernam, and his invention is known as the One Time Pad. The trick is to ensure that there is as much key material as there is plaintext, that the key material is entirely random and perfectly secret, and no part of the key material is used more than once. In practical terms, though, Vernam's system is largely useless. Generating truly random material is difficult, as is distributing a huge amount of it in secret and ensuring its destruction post-use.

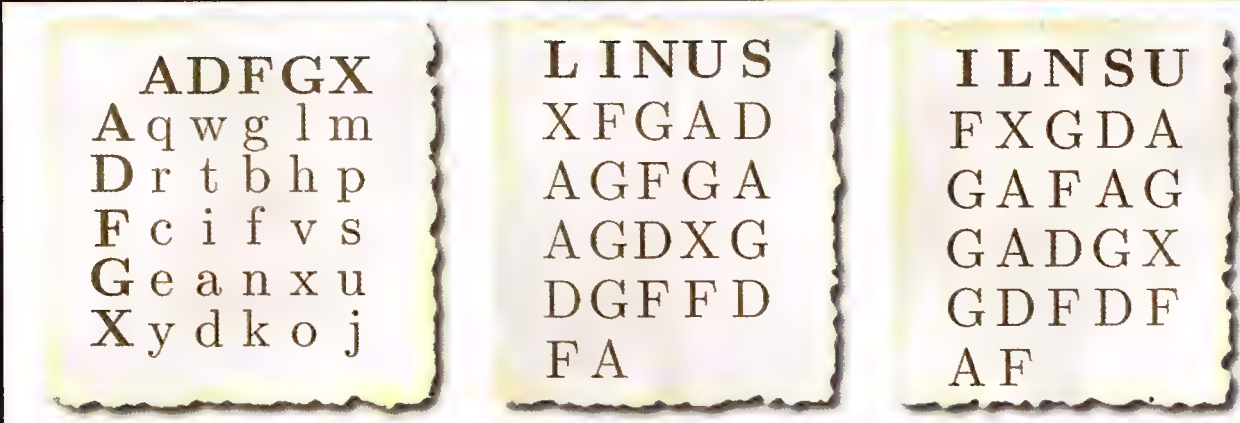
ENIGMATIC MATHEMATICS

Wartime cryptography relied heavily on codebooks which contained daily keys, and these had a bad habit of falling into enemy hands. Once such a breach occurred and news of it reached HQ, generals were faced with the tremendous logistical problem of alerting relevant personnel as to the breach and then manufacturing and distributing new key material. Long-range naval missions often failed to receive this, necessitating that messages be retransmitted using old keys. This exchange was sometimes intercepted, providing clues as to the new key. During World War I, the decrypting of the Zimmerman telegram (which invited Mexico to ally with Germany) was instrumental to American involvement in the war.

By World War II the Germans had upgraded the Enigma series of machines to present a sufficient cryptographic challenge to Bletchley Park. Polish researches had broken the original design as early as 1932, and just prior to the outbreak of war they shared their intelligence with the British. Alan Turing designed the Bombe machine, which by 1940 was doing a fine job of breaking Jerry comms.

The Enigma machine, despite having a huge number of rotor, plugboard and stecker settings, had a weakness in that a letter was never encrypted to itself. This vastly reduced the amount of work that the Bombe and the computers (usually women with a good eye for detail and skill at crossword puzzles) had to do. After a letter was typed on the Enigma, the cipher alphabet was changed by the rotor mechanism, in a manner not dissimilar from the Vigenère cipher. There were other layers of encryption too, but a lot of these were constant settings made redundant when Enigma machines were captured. By the end of the war there were around 200 Bombes in use throughout England. The Americans, being in a much better position for obtaining supplies, were able to build and design 125 much faster Bombes, and the Allies were able to farm out work to these remote behemoths via (encrypted) cable.

Turing's genius notwithstanding, much of the Enigma traffic was decrypted thanks to sloppy operational security. Message keys could have been changed with every transmission but



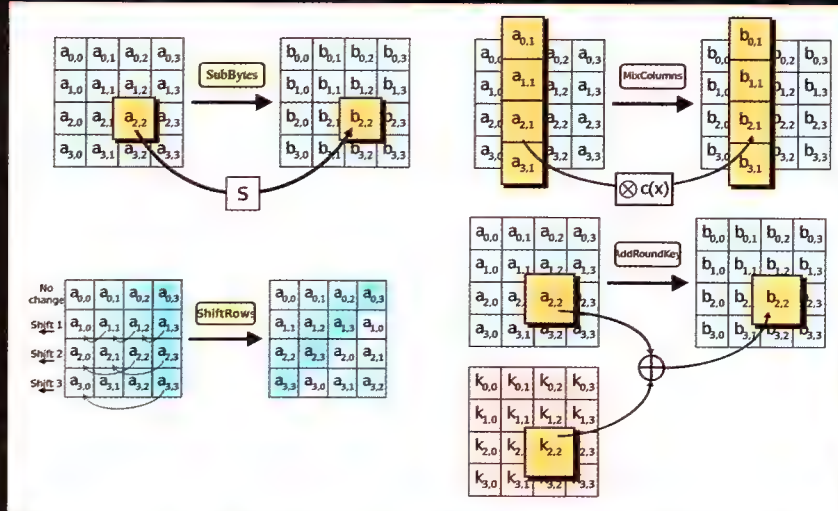
Don't panic, Colonel

This triptych shows another WWI example: the ADFGX cipher (these letters were chosen because they're different in Morse code). The first plate is the fractionating key: it encodes each letter of our alphabet (sans the letter z because the LXF style guide doesn't like it) into a bigram, so that our message 'kernel panic' encodes to XF GA DA GF GA AG DX GD GF FD FA (the

space is ignored). In the second plate, we fit this message onto a grid below a second keyword, 'LINUS', which is our transposition key. In practice, a longer transposition key would have been used, and both keys would be changed according to a daily code book. We rearrange the columns by putting the second key in alphabetical order, and then read off the ciphertext column-wise. Thus our encoded message is FGGA XAADF GFDF DAGD AGXF.

Advanced Encryption Standard

AES was introduced as a replacement for DES in 2001. To date it has defied all cryptanalytic efforts to find weaknesses. One reason for its selection was its relatively simple structure. There are four main layers, repeated over several rounds. With a bit of imagination, one can see echoes of the ADFGX cipher in the ShiftRows stage. The SubBytes stage is the only non-linear part of the cipher. Typically linear operations are much quicker to carry out, but without a non-linear stage a cipher will be trivial to break using the methods introduced by Matsui.



were not, or when they were the change was only slight and easily guessed. Numbers were often spelled out, so 'einsing' was a common technique — looking for occurrences that might decrypt to 'eins'. If numerals had been allowed, this technique would have failed.

In the 1970s, two developments brought the cryptography game into the computer age. The first of these developments was the Data Encryption Standard, a block cipher based on work by Horst Feistel at IBM. Prior to its standardisation, it was slightly modified at the behest of the NSA. With no reasons being cited for these agency-mandated changes, suspicions were raised about a possible back door. Two decades later, it emerged that the opposite was true: the S-boxes of the original cipher were susceptible to a technique called 'differential cryptanalysis', which at the time (cryptography being considered a munition) was classified. The NSA changes made the cipher more resistant to the technique, although they did also recommend a smaller 48-bit, as opposed to 64-bit, key size. Being the first publicly available cipher, DES became the subject of intense scrutiny and in many ways bootstrapped serious academic study of cryptography.

While the thousands of pages of journal articles on the subject provide all manner of theoretical attacks on DES, by far its most serious weakness is the short key size. IBM and the NSA eventually compromised on a nominal 64-bit key, but eight of these 64 bits were redundant checksum bits. At the time of its introduction this was probably sufficient, but in the early 1990s machinery was proposed that could brute-force a key within hours. In 1997 an internet-wide project successfully cracked a DES key for the

first time. In 1998, the Electronic Frontier Foundation built a device (for a princely \$250,000) which successfully cracked a key in a little over two days.

Among the other attacks on DES it's worth mentioning Matsui's 'linear cryptanalysis'. The attack involves building up approximations to parts of the cipher by finding modulo 2-linear expressions that hold with a probability significantly different from 0.5. By collecting a huge number (243) of plaintext-ciphertext pairs, one can deduce a sufficient number of bits of the key that the remainder can be brute-forced. Linear expressions can be found speedily thanks to the Walsh-Hadamard transform, and modern ciphers all are very careful to include a heavily nonlinear component to mitigate against these attacks. In some ways one can look at Matsui's work as an abstraction of basic letter frequency analysis, using characteristics of the cipher rather than the language, and 1s and 0s rather than characters.

GOING PUBLIC

The other good thing to come out of the '70s was Public Key Cryptography. This finally solved the problem of being able to communicate securely without first having to meet in order to establish a shared secret. The method is called the Diffie-Hellman key exchange, after the gentlemen responsible for its invention. It exploits the chiral mathematics of finite fields, in which it's straightforward to exponentiate an element (that is, raise a number to a power), but very difficult to conduct the opposite process, known as the discrete logarithm. Thus field exponentiation is an example of a 'one way function'. The illustration (at the foot of the facing page) shows an example of the exchange between Alice and Bob, who are fairly ubiquitous in cryptographic

literature. The shared secret $s=gab$ can be calculated by both Alice and Bob. An onlooker, Oscar say, can see the public keys A and B , and the exchange parameters g and p , but these are of no help in deducing the shared secret s unless one of the secret keys a or b is also known.

Once thusly established, the shared secret s can be used as an ephemeral encryption key for a symmetric cipher, such as DES. The secret keys a and b could at this point be destroyed, which would ensure so-called perfect forward secrecy, but a proper public key infrastructure would require that private and public keys remain largely immutable. Further, public keys should be as well-advertised as possible, to reduce chances that a man in the middle, say Mallory, could impersonate either party with a bogus public key: the key exchange provides confidentiality, but doesn't of itself guarantee authenticity.

To achieve the latter, one needs to be sure of whose public keys belong to whom. To do this in general, one requires a trusted third party, known as a Certificate Authority (CA), to act as a directory of keypair owners.

Since public key cryptography is such a different animal from its private counterpart, one can use various bits of mathematical trickery to reduce the search space to one significantly smaller than that of a brute-force attack. This being so, the classic public key algorithms all have much longer keys. For example, the AES algorithm is considered secure with a 128-bit key, but people are already concerned that 1,024-bit RSA keys are no longer secure. The new-fangled Elliptic Curve cryptography, based again on discrete logarithms but in a more abstract algebraic space, offers shorter keys, but still of the order of twice the security

Development of modern principles

Over the last 150 years, a few key principles have been developed which (with small adjustments to allow for new technologies) still give a good idea of what the cryptography game is all about. The first is Kerckhoffs's [this apostrophe catastrophe brought to you by Wikipedia] principle: that knowledge of the encryption method alone should not be considered a threat to the security of the message. So long as the key is not compromised, this knowledge will be of no help. This is counter to the idea of security by obscurity, which, although it intuitively might seem reasonable, is considered bad form nowadays. The CSS copy-protection system used on DVDs was broken in 1999 after reverse engineering of the Xing software revealed a player key and the underlying algorithm

(which turned out to be woefully poor). Likewise, the Keeloq mechanism for remotely unlocking vehicles was broken in 2006 after part of its design was leaked.

Claude Shannon is often called the founder of Information Theory. In 1949 he introduced the ideas of Confusion and Diffusion for ciphers. Confusion advocates that the relationship between plaintext, ciphertext and key should be as complicated as possible. In terms of modern block ciphers this should mean each output bit depends in a non-linear manner on several key- and input bits. Diffusion refers to the idea that changing one key- or input bit should have a fairly drastic effect on the output. Ideal diffusion results in the strict avalanche criterion: that each output bit should change with probability 0.5 when one key- or input bit is flipped.

parameter. The security of all these public key systems rests on the supposed intractability of factoring integers and the discrete logarithm problem. While mathematicians have studied these problems extensively and come up with some good tricks for speeding up the process, they both remain sufficiently time-consuming to solve as to still be considered secure – at least on conventional hardware.

Up until 1992 cryptographic software was classified as a form of munitions in the US, and even after this date was governed by export restrictions. These precluded the export without licence of any software using a key length of more than 40 bits. This led to a lengthy criminal investigation of PGP founder Paul Zimmerman, which ended in nought. Zimmerman came up with novel ways of circumventing these restrictions, including publishing the source code as a book, protected by the First Amendment. Netscape was forced to release a crippled 'International Edition' which permitted only 40-bit SSL keys, in contrast to its 128-bit US edition.

ARE YOU SHOR?

In 1994, Peter Shor announced an algorithm which could be run on a

quantum computer which would enable it to (among other things) factor integers and compute discrete logarithms much faster than a classical computer. While no one has yet succeeded in building the right kind of quantum computer, there's sufficient concern to give rise to a burgeoning field of study known as post-quantum cryptography.

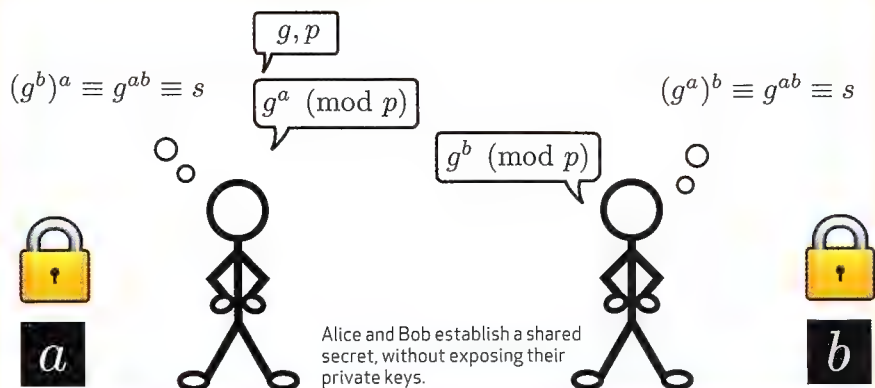
Perhaps a more practical concern is the problem of producing secure keys in the first place. This relies on being able to produce a sufficiently random stream of bits, which computers are notoriously bad at. On Linux we have the `/dev/random` and `/dev/urandom` nodes (go on, run the `cat` command on them), which both harvest entropy gathered from (among other sources) keyboard and mouse input in order to augment a pseudorandom number generator (PRNG). This is why it's good practice to make erratic mouse gestures and batter the keyboard when running, for example, the `ssh-keygen` command.

A very early version of Netscape contained a weak PRNG that was seeded using the time of day and process ids. Since an attacker would be able make educated guesses as to these variables, the supposedly randomly generated SSL keys could be broken.

In 2008 sysadmins were sent into a widespread panic when it was revealed that OpenSSL was generating weak keys, and had been doing so for two years. More recently, Ed Snowden has revealed that the NSA paid RSA security to use a generator called Dual EC DRBG as the default in their software. The constants that the NSA recommends to initialise this generator with are suspected to have been contrived in such a way as to provide a back door into the algorithm.

Besides ciphers, an important concept is that of a hash function. This scrambles an input to a fixed length output (so if the input is longer than the output there could be collisions) in a one-way manner. Hashed passwords in Linux are stored in `/etc/shadow`. Originally the MD5 hashing algorithm was used, but nowadays SHA-512 is becoming the standard. Often we hear news of hackers managing to obtain databases, which often contain hashed passwords. If you are in possession of a large database, the popular John the Ripper password cracker is able to weed out any weak passwords in a matter of minutes. For research purposes we ran it on a real world database (which has several thousand users), and managed to get 2,500 passwords over the course of a few hours. Other tools such as `oclHashcat` can leverage GPU power as well, so database security is important, as is changing your password if it is compromised.

In sum, we have seen great changes in how we encrypt our secrets, but it's important to see how we have been inspired by the past. Unfortunately, we make the same mistakes too – whenever security is breached, it is far more likely to be due to poor security practice than weaknesses in the cipher. Misconfigured servers, phishing attacks, malicious or lazy operators are by far the greater problem. ■



howto

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

HARDWARE

CPU OR GPU BOTTLENECKING

I have ordered one of the Pentium Anniversary Editions, and already have an ASUS GeForce GTX 750 Ti 2GB OC. Is this a good match, or will one of these parts be a performance bottleneck? Also, what would be a good mobo for this build? Normally I would just get the most expensive one I can afford, but this system will already have some built-in limitations, so I don't want to go overkill.
— Chris Hall

Chris, if you mean the unlocked Pentium Anniversary Edition, we think it's a good match. For those who don't know, the Pentium G3258 Anniversary Edition is an unlocked budget dual-core chip. The staff at APC like to call it the Pentium K to denote its unlocked status. With a base clock of 3.2GHz, the part does not have Hyper-Threading but should overclock into the 4GHz range easily. You asked if that would create a bottleneck situation and it shouldn't. However, you didn't say what you intend to do with the system. If it is primarily a gaming box, you're in good shape as most games are still optimised for dual cores. If you intend to do a lot of video editing or multi-threaded tasks, that dual-core CPU will certainly be the limiting factor. The good news is you can make up for some of the performance loss by overclocking the chip. As far as motherboard expenditures, you should probably buy primarily on the features you need. The best example is Thunderbolt 2. If you don't intend to use it, don't pay for it. If you never intend to overclock or run multi-GPUs, pick a board without those features to save some cash.

— APC staff

HARDWARE

SSD UPGRADE

I have an all-in-one computer, which came with a hard drive, Windows 8.1 installed, and a recovery partition. My problem is I want to replace the hard drive with an SSD, but I have no Windows disk to do a



CPU and GPU should be evenly matched to prevent performance bottlenecks.

fresh install to the SSD. I have created a separate recovery drive from the recovery partition, but queries on the internet indicate a fresh install to a new drive cannot be done from either the recovery partition or drive. I can't install the SSD along with the HDD because the motherboard ASUS used for this unit only has two SATA connections available, one used for the optical and the other for the HDD.

— Hal Smith

This is an advanced manoeuvre, but it is possible. Manufacturers obviously don't want that recovery partition, which is a bootable OS, copied to any old drive, so they usually lock it down. However, if the hard drive that came with your system dies, then you'd lose your only copy of Windows that you rightfully purchased, so OEMs usually give you the option of making recovery disks in case of hard drive failure. This will copy the hidden partition with the OS on it to an

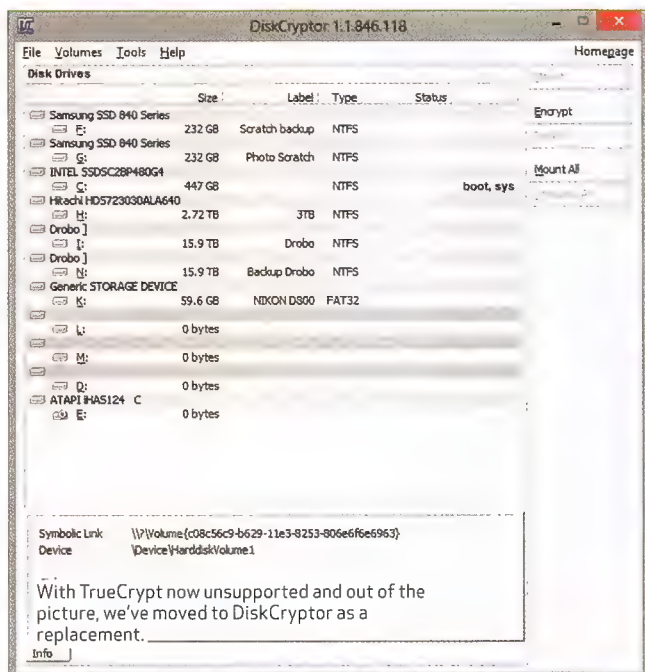
external drive, so you can copy your OS in "factory condition" to a new hard drive in the future. What you need to do is make those disks (we usually use an 8GB USB key for this), which creates a bootable backup of the recovery partition. Once that's complete, pull your hard drive and install the SSD. Next boot from the new recovery backup (the USB key, if you used one), and it should give you the option to recover your OS to a drive. Select the SSD and it should install. You should just buy an external USB enclosure for your old hard drive and use it for data storage, but be sure to back up that data either to the cloud or to another external drive.

— APC staff

SECURITY

TRUECRYPT REPLACEMENT

What encryption programs would you recommend to replace the now-



The original Pentium 4 was only a 32-bit chip, so it can't run 64-bit operating systems.

"If you intend to do a lot of video editing or multi-threaded tasks, that dual-core CPU will certainly be the limiting factor. The good news is you can make up for some of the performance loss by overclocking the chip."

Reinstall Disks



Most major manufacturers provide an option to create recovery media — either to DVD or a USB drive.

unsupported TrueCrypt? I don't need any fancy automated backup or anything, just something easy to lock down my storage drives when I'm not using them.

— Dan

We've also been looking for a replacement for TrueCrypt, as it was our go-to free app for password protecting our important files. For those who aren't aware, the makers of TrueCrypt ended support in May 2014 when Microsoft put a bullet in the dome of Windows XP. The TrueCrypt team recommended everyone just move to the integrated encryption tools built into Windows Vista, and Windows 7/8. However, we did find an alternative named DiskCryptor. It's free, and each release is signed with

the author's PGP key, so it's quite safe. The only catch is it only encrypts entire partitions instead of individual folders like with TrueCrypt. Still, it could be useful for an external drive, a USB key, or even your boot drive if you're a bit paranoid.

— APC staff

HARDWARE

TEACHING AN OLD PC NEW TRICKS

I have two older PCs I'm considering converting to a Windows Home Server 2011 system. One of these will be set up to work with an external eight-bay (8TB) eSATA box, and whatever PC I use will get multiple Gigabit Ethernet cards. The first PC has a Pentium 4 Northwood chip running at 2.4GHz, with 4GB of RAM running XP SP3 32-bit Home Edition. It has

500GB of PATA drives on board, an EVGA GeForce 6800, and is currently used to run some older printers that don't have Win7 drivers. It doesn't connect to the net, and everything runs like new including the printers.

The second is a Core 2 Quad Q9550 Yorkfield 2.85GHz, with 8GB of dual-channel RAM, running Win7 Home Premium 64-bit, a 1GB Gigabyte I-Ram drive (for Temp, Tmp, and IE files), 500GB of SATA II HDDs, and a Gigabyte GeForce GTX 550 1GB video card. It is currently used as a secondary gaming rig for guests. This PC does have net access and everything also runs like new. Do you think the P4 will work well as the WHS 2011 server (with all the extras, such as media streaming), or will it just not have the horsepower? (I'm thinking of how many newer NAS boxes only have Atom or ARM processors and low RAM.) I was also thinking of a dual boot setup to run the old printers.

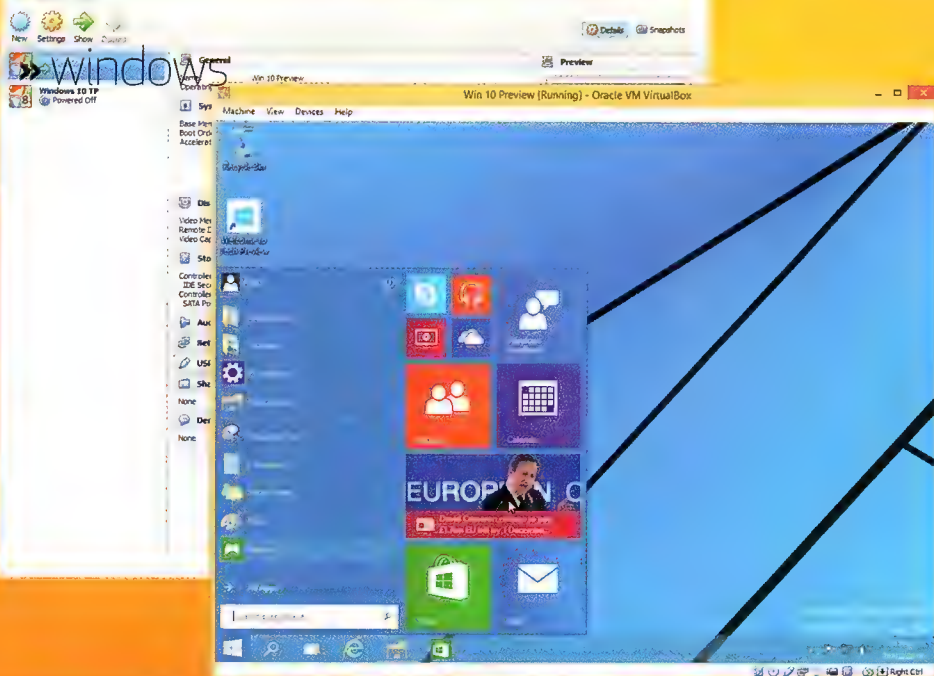
— George

First, you're out of luck with the Northwood Pentium 4 machine. Windows Home Server 11 is a 64-bit only OS and requires a CPU with x86-64 support. The Northwood Pentium 4 (the original Socket 478 CPU) was 32-bit only. Only later versions of the P4 and Pentium D had 64-bit support once Intel realised AMD was going to win that battle. The Core 2 Quad Q9550 is 64-bit so you'd have to use that machine. That may be overkill for a home server as there are lots of ARM-based and Atom-based NAS units out there. In our experience though, those machines have atrocious performance and even the most basic Celeron NAS units are faster.

— APC staff ■

how

windows



Install the Windows 10 Preview

Alan Dexter shows you how to try Windows 10 without damaging your machine.

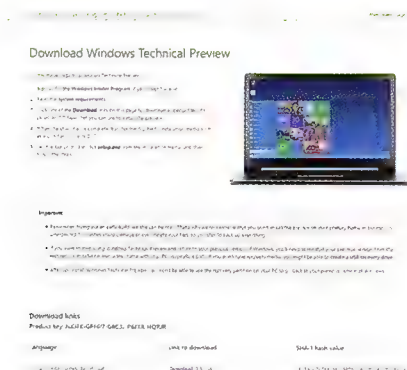
Windows 10 is lining up to be something special, and getting to grips with what's new and discovering how to do the things you used to are just a couple of the reasons why you might want to install the Technical Preview.

Installing it on your main PC isn't a great idea though, because this is a preview and thus has no guarantees

about stability. Installing it on a spare machine is the preferred method, simply because you'll get a better idea of what the actual experience will be like. However, as this is an early build, it isn't in a state that you can use every day without problems — games not working, things being a bit flaky and driver issues, to name a few. Because of this, we'd recommend installing it onto a virtual machine. Here's how.

Install Windows 10

Don't worry about making your PC unstable — install the OS on a virtual machine.



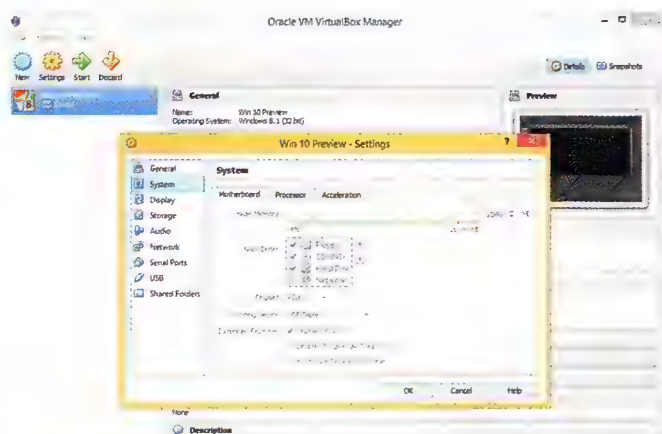
1 DOWNLOAD WINDOWS 10 TECH PREVIEW

First, download the right version of the Windows 10 Technical Preview from tinyurl.com/pbh8gmh. Pick the language you understand best, and work out whether you want the 32-bit or 64-bit rendition. There's not much in it, but if you want to assign more than 3GB of RAM to the OS, you need to go with the latter, so that's what we've used. Write down the product key, too.

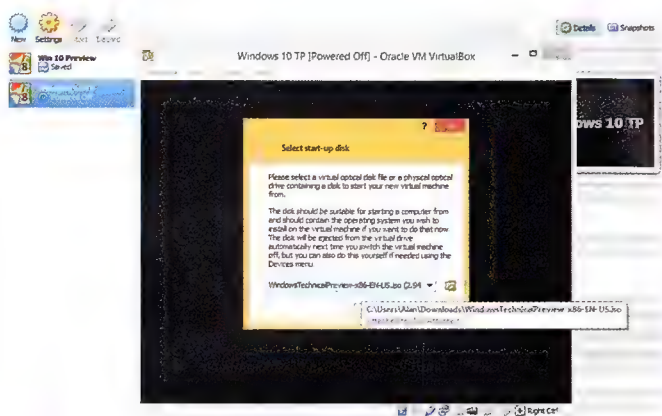


2 INSTALL ORACLE VM VIRTUALBOX

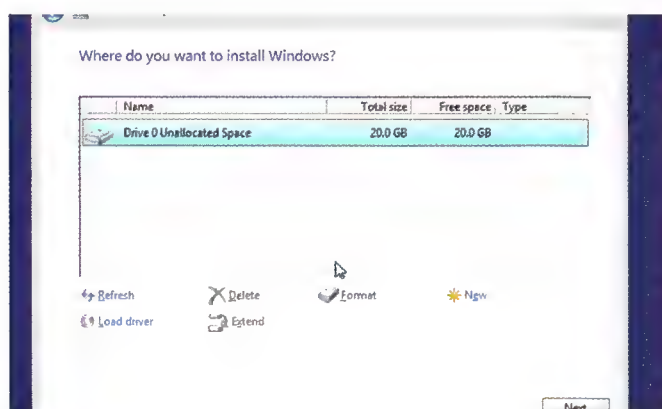
If you're looking to install your OS on a virtual machine, you'll need the software to do it. Our favourite is Oracle VM VirtualBox. Grab it free from www.virtualbox.org and install it with the default settings. During the installation you will be briefly disconnected from your network, so make sure you're not downloading anything at the time.



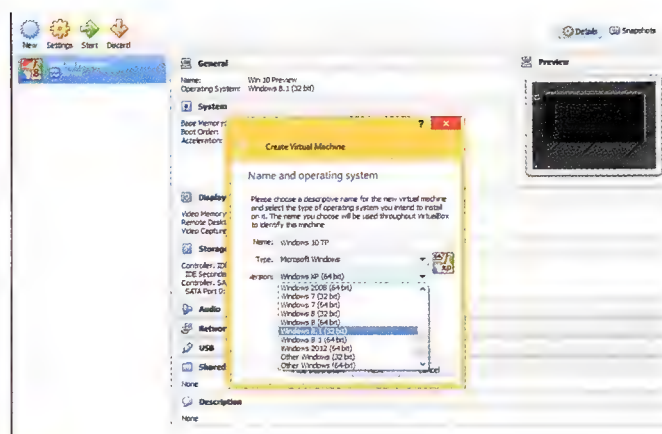
3 CONFIGURE PRIOR TO INSTALLING VirtualBox lets you configure the core settings of your VM, from how much memory it has available to how many processor cores are present. There are more esoteric options too, such as support for advanced Physical Address Extensions on the CPU (essential for Windows 10). You can experiment, but there are defaults that work just fine.



5 A VIRTUAL INSTALLATION Once the drive has been created, you can move on to actually running it. Select your virtual machine and hit Start. You'll be asked to select a startup disk, so point your virtual machine's optical drive at the Windows 10 ISO you downloaded in step 1. You'll need to hit a key when the machine boots up to install from the disc.



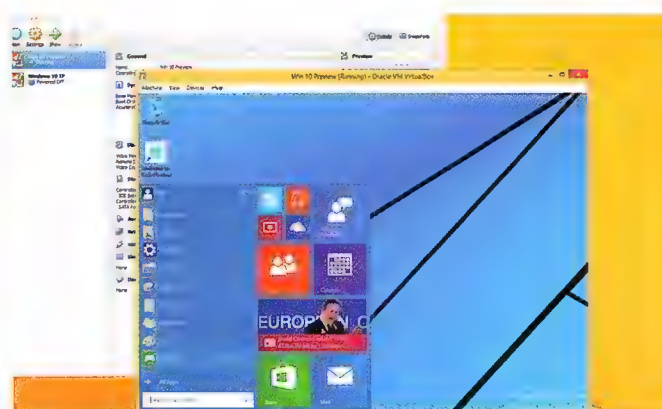
7 LICENSED UP You'll have to accept the licensing info on the next screen (go on, read it all, we dare you), and then on the installation type screen select the second option — 'Custom: Install Windows only (advanced)'. Select your virtual drive on the next screen and click Next. Windows 10 will now do all the hard work.



4 SET UP YOUR VIRTUAL MACHINE Click New, enter Windows 10 TP as the name, set the type to Microsoft Windows and set the version to Windows 8.1 (32-bit) or (64-bit). The default amount of memory is fine, but 2GB or even 4GB is better. Select 'Create a virtual hard now' and leave the drive as a VDI device. Have this drive dynamically allocated and hit Create.



6 STANDARD INSTALLATION The first thing you'll see is the Windows Setup screen. You can't change the language that is installed (which is why we said to pick your download carefully), but you can set your time and currency format to something a little more useful. Once you're happy, hit Next and then click on the big 'Install now' button on the next screen.



8 FINISHING OFF You don't have to sign up for a Microsoft account if you don't want to. To configure Windows with a normal login, click 'Create a new account', then click 'Sign in without a Microsoft account'. Now you're ready to take Windows 10 for a spin. Start by pressing Start on your keyboard and revelling in the return of the Start menu. ■

Tell Yosemite what to do

Matthew JC. Powell shows you how to add spoken commands to the latest version of Mac OS X.

The ability to use speech recognition to control your Mac has been in Mac OS since well before OS X – though, to be fair, it hasn't always worked terribly well. Apple has kept this particular light hidden under a bushel called "Speakable Items", and it was probably for the best.

For one thing, until reasonably recently the Mac's ability to recognise speech has been fairly limited. For another, the range of commands to which your mac could respond was limited to what Apple had built in to "Speakable Items" – you could not roll your own.

All that changes with Yosemite, which has dropped the sadly neglected "Speakable Items" once and for all (kind of) and added functionality to the sadly neglected Automator. Using a new type of Automator Action, you can get your Mac to do anything Automator can do. Which is, as we might have mentioned before, just about anything.

To illustrate, we'll build on an example we built earlier – toggling the visibility of items in the Finder. There are two approaches we can take to this, since Automator can be used to run apps and it can also be used to trigger AppleScripts. So, if you followed the tutorial in issue 405 and created an application to toggle hidden files, you can simply trigger that – if not, you can type in the script.

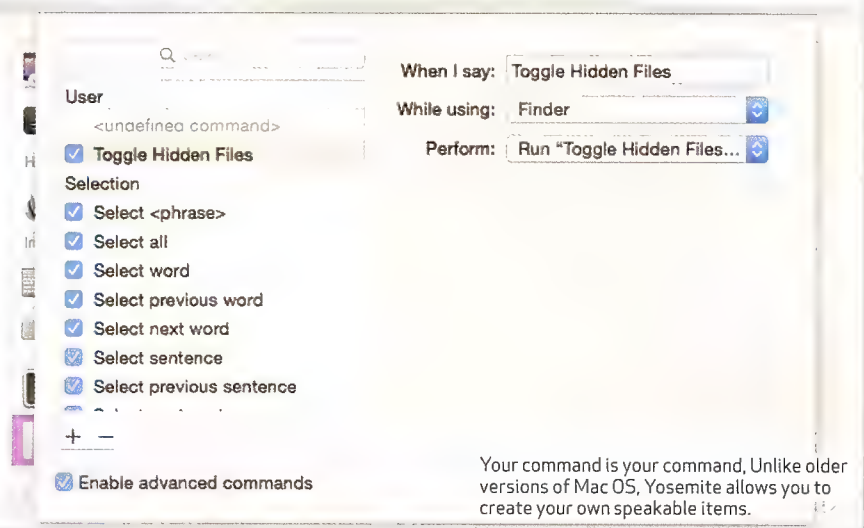
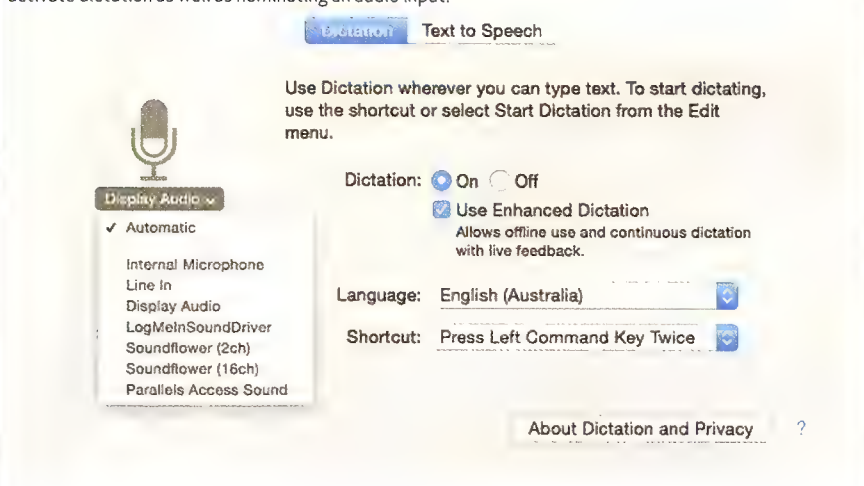
METHOD 1: ONE WE PREPARED EARLIER

The first thing you're going to want to do is open System Preferences and click on Dictation & Speech. In that panel, make sure that 'Use Enhanced Dictation' is selected. This allows your Mac to process speech recognition locally, rather than sending data over the network the way Siri does on your iPhone. It's about a half-gigabyte download, but if you've got the space on your hard drive it's worth it.

Under the microphone icon on this panel you can also select an audio input. The default is Automatic which means it will simply use the same audio input as you've set for the system. But if you wanted to, for instance, use a USB headset for dictation but not for Skype, you can set something different here.

You can also use this pane to set the keyboard shortcut for activating

Turn on your ears. The Dictation & Speech preference pane is where you define the keyboard shortcut to activate dictation as well as nominating an audio input.



Dictation. The default is to tap the fn key twice.

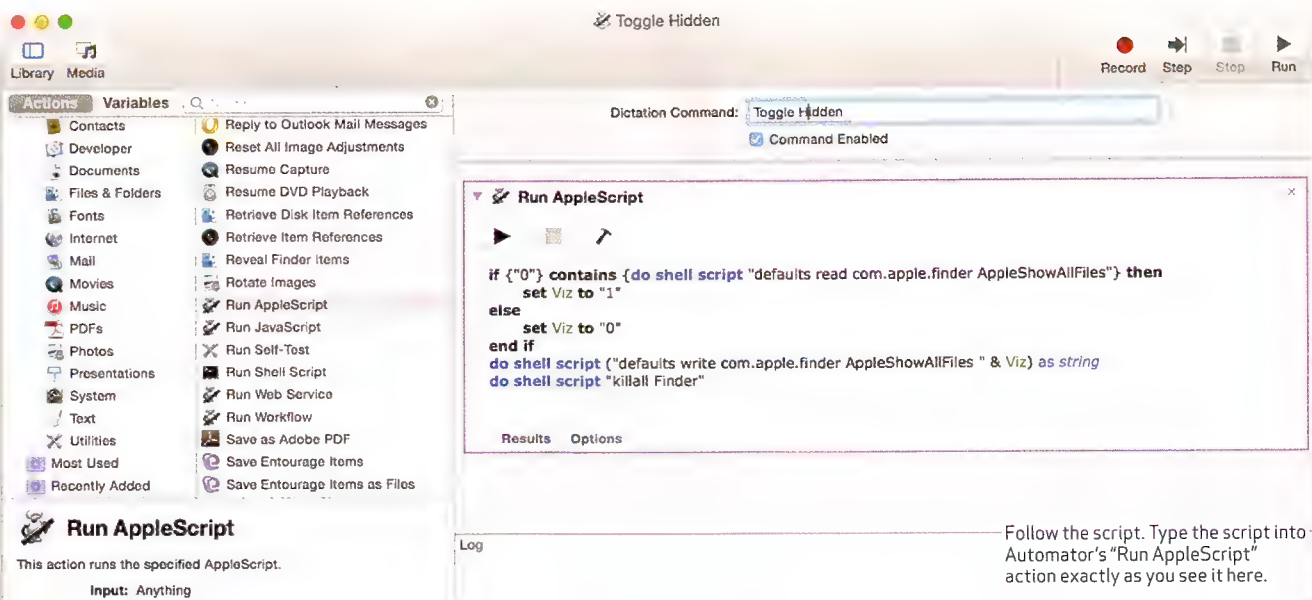
Next, also in System Preferences, click on Accessibility and, in the left-hand column, scroll down to Dictation and then click on 'Dictation Commands...'. This is basically the same as what used to be called 'Speakable Items' but the bonus is you can add your own now.

In the window that opens, tick the box to 'Enable advanced commands'. You'll see a +/- symbol appear underneath the left-hand column. That's what you use to edit the list of speakable commands.

Click on the + symbol. Then in the

box after 'When I say', type in a phrase you want to use to activate your command. Next to 'While using', use the pull-down menu to select Finder, since it's unlikely you'll want to toggle the visibility of files in any other application.

Finally, in the pull-down menu next to Perform you can choose an action to perform. In this case we want to run an Automator workflow, but it's one we saved as an application. So you can choose either 'Open App...' or 'Run Workflow...' and then select the 'Toggle Hidden Files' app we created earlier. Click Done and you're done.



METHOD 2: WRITE THE SCRIPT

You still need to activate 'Use Enhanced Dictation' and 'Enable advanced commands' in their respective places in System Preferences for this to work. However, you don't have to click + to add a command – we're going to do that in Automator.

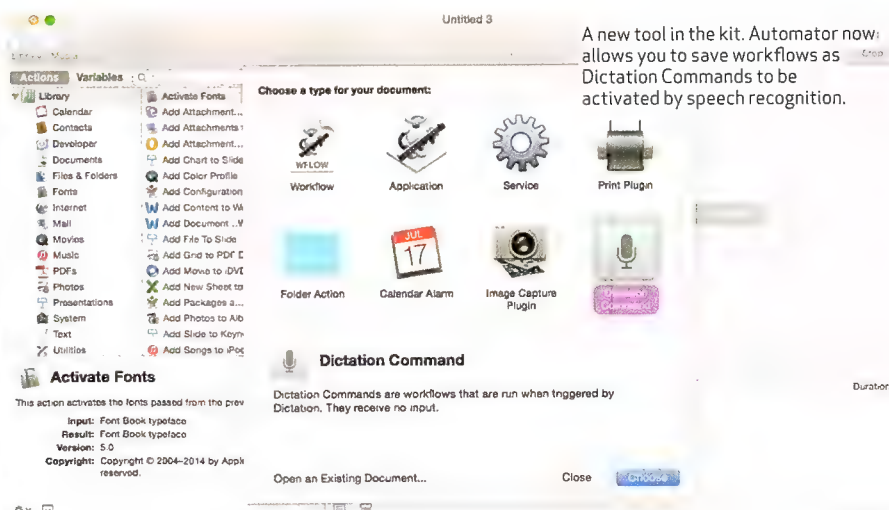
Open Automator, and in the project palette, select 'Dictation Command'. In the text box next to 'Dictation Command' type the text you want to use to activate this command.

Next, build the workflow you want to activate with speech. For this example, we're going to write an AppleScript, but as you can see in the columns at the left of the Automator workspace, there is a huge number of things you can do with no coding at all. Simply drag things over.

For this example, drag the action called 'Run AppleScript' into the workspace (to make it easier to find, click on Utilities in the left-hand column first). Then, type the AppleScript as shown in the screenshot. Don't worry about the fancy formatting – Automator will take care of that for you. Thankfully, Apple hasn't changed the way ShowAllFiles works in any significant way in Yosemite, so this script written for Mavericks will still work just fine.

For your reference, this script first checks the contents of a variable called 'ShowAllFiles' in the Finder's preferences. Then if it finds that 'ShowAllFiles' is set to 0 it changes it to 1 and vice versa. Then it restarts the Finder to make the change active. It's about as simple as AppleScripts get, but useful if you ever need to find files that Apple doesn't think you need to see.

Once you've typed in the script, click the play button to test it. This will



Downloading Enhanced Dictation...

256 MB of 329 MB — About a minute remaining

Act locally. Enabling Enhanced Dictation means downloading the resources necessary for your Mac to do speech recognition without sending anything over the network. Even if you had activated this in Mavericks, there's still more to download in Yosemite.

Cancel

actually run the script, so some invisible files may suddenly appear on your Mac. Don't be frightened – run it again and they'll go away. You'll also notice that once you've tested the script it'll be nicely formatted.

Next, ensure that the 'Command Enabled' box is ticked, and save your workflow. Give it a name that will roughly correspond to what it does.

If you go over to 'System Preferences > Accessibility > Dictation > Dictation Commands' you'll see your workflow there in the list.

To use your workflow, simply use the keyboard shortcut to activate Dictation. A little microphone appears on screen to indicate the Mac is listening. Speak your command, and it will be done. ■

Teach Siri about family relationships

Make Siri more personal by telling it all about your family.

Siri is great fun to use, but it becomes even better when you let it know who your family members are. All you have to do is make sure each member of your family has an entry in the Contacts app, and then tell Siri about your relationship to that person.

In this tutorial we're going to show you how to add relationship information to your contact card via Siri. Adding relationship information enables you to use Siri in a much more natural manner. You can say things like "Send a message to mum" or "Hey Siri! Send an email to my brother" or "When is my dad's birthday?". This is another step to turning Siri into your

personal assistant.

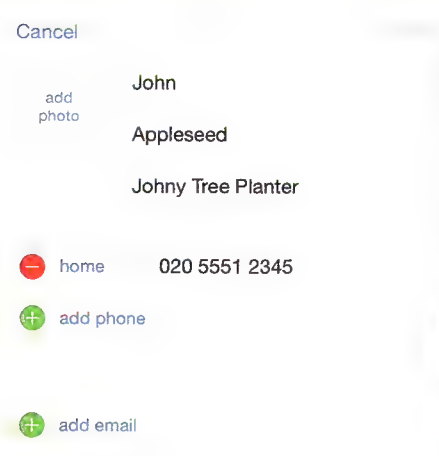
It's easy enough to get this information added to Siri: simply ensure that your Contacts app is up to date with all your family members, and then let Siri know who is who.

"This is another step to turning Siri into your personal assistant."



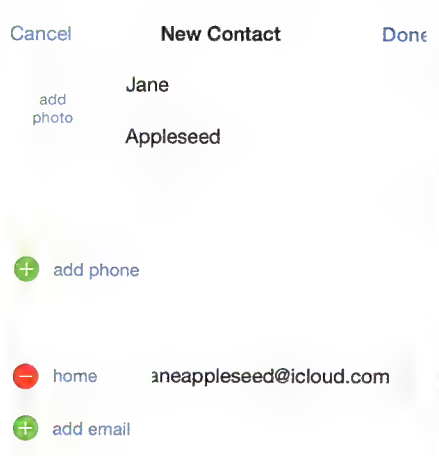
Everyone in!

Add your family to contacts.



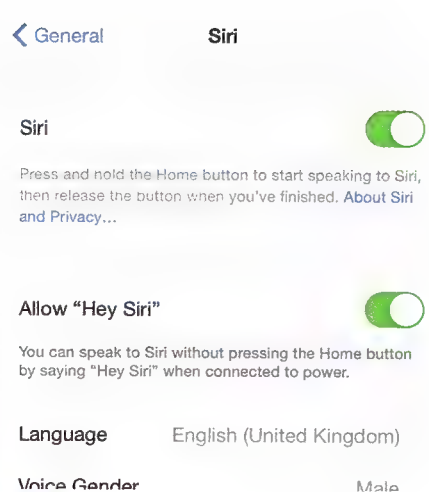
1 START WITH YOURSELF

You should start by making sure your own details are up to date and correct. Tap on Contacts, and find your name in the sidebar on the left. Now make sure your name, phone number, and email information are present and correct. If you want Siri to call you something other than your first name, you can pick a nickname by tapping 'Add Field > Nickname'.



2 ADD YOUR FAMILY

Next you should make sure all of your immediate family is listed in the Contacts app. If you need to add a person tap the Add (+) icon and enter their first and last name, then their email address and any other information you have. Siri and Contacts look much better using images, so tap 'Add Photo > Choose Photo' and pick an image from your photos.



3 TELL SIRI WHO YOU ARE

Finally you need to make sure Siri knows who you are. Tap on 'Settings > General > Siri > My Info' and choose your own name from the Contacts list. Siri will now respond to you by name. Test that this has worked by holding the Home button and saying to Siri "Who am I?" Siri will now respond to you by either your first name or the nickname you chose earlier.

Tell Siri who your family is

Introduce everyone.



1 ADD YOUR PARTNER

The first relationship most people want to add is their partner. Hold the Home button to activate Siri, and say something like "John Appleseed is my husband" or "Jane Appleseed is my wife". Note that Siri also recognises other relationships such as partner, fiancé, girlfriend or boyfriend. Siri will request that you confirm you want to add the relationship.



2 ADD OTHER PEOPLE

You can continue adding people to Siri by telling Siri who they are. You can add your mother, father, brother, sister, and even tell Siri that people are your friend, assistant or manager. You can even add custom labels, such as "tennis coach" or "dancing partner", if you like. Just tell Siri who all the important people are in your life one by one.

< Contacts

Edi

United Kingdom

spouse

Jane Appleseed

child

Abigail Appleseed

Game Center

scout_walker

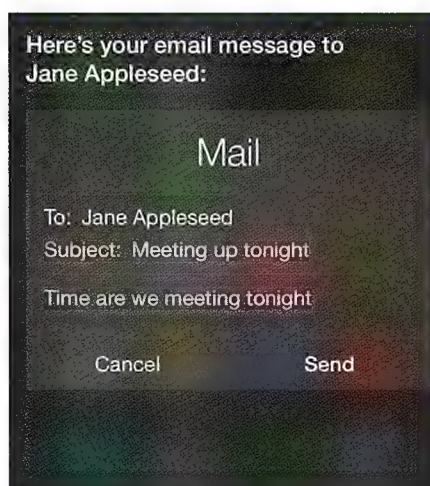
Send Message

3 CHECKING RELATIONSHIPS

All the information about your family is stored in your personal card in Contacts. Tap the Contacts app and scroll down to find the Related Names section to find all the family relationships. To remove a relationship, tap Edit and then the red Remove icon next to the person. Finally, tap Delete. We find it easiest to add relationships using Siri.

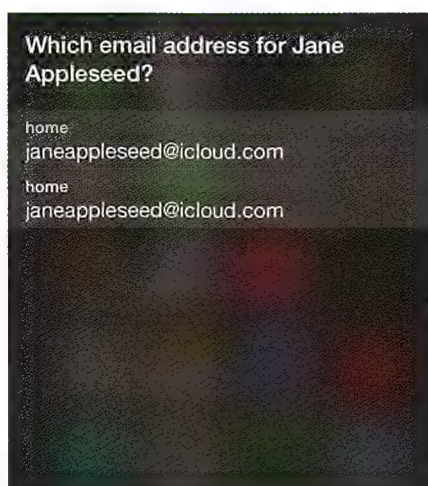
Ask Siri questions about your family

Send emails, make calls, even stalk them!



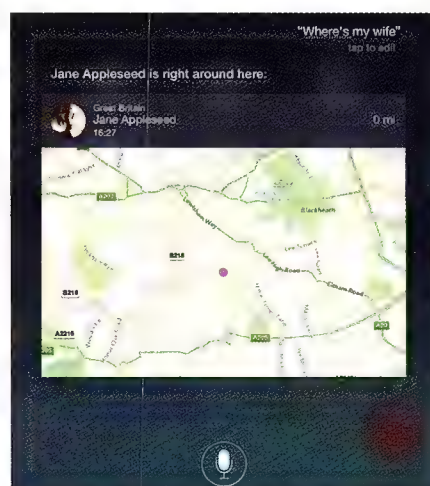
1 USING NAMES

Now that all your relationship information is in Contacts, and Siri knows who is who, it's time to put Siri to work. You can send an email to your spouse just by saying "Send an email to my wife". Note that you have to say "my wife" or "my son" for Siri to understand — you cannot say "send a message to the son," for example (not that you probably would).



2 GET PERSONAL WITH SIRI

You can now use Siri to create reminders, set up meetings, start FaceTime conversations and send messages, all using relationship titles. Just say "I'm meeting with mum tomorrow morning" or "FaceTime my dad". Using informal family titles makes Siri a lot more personable; most people are used to saying "mum" and "dad", rather than using full names.



3 FIND YOUR FAMILY

If Find My Friends is set up on your iPhone, you can use Siri to find members of your family. Just say "Where's my wife?" to find out where your other half is at the moment. Siri displays a map with their current location. Integrating Siri with Find My Friends is a great way to keep up to date with the whereabouts of your family members... or stalk them!

Create hyperlinks using macros

Helen Bradley shows you how to make hyperlinks programmatically in Excel

One handy way of moving around an Excel workbook is to use hyperlinks. You can create hyperlinks that, when you click them, take you to a different sheet in the current workbook or to one in a different workbook. You do this by creating the link to text stored in an Excel cell. In this month's macro we'll create a list of sheets in a workbook which are hyperlinked to the actual sheets themselves.

This macro will help you when you're working with a large workbook. It creates a new sheet and populates it with a list of the names of all the other sheets in the file each of which is a clickable hyperlink.

The macro first warns you it is about to delete any existing sheet called Sheet List and it does so and then adds a new one and adds a column title. Then it processes the array of sheets in the workbook creating a cell hyperlink for each using the sheet's name as the cell entry and hyperlinking this to the actual sheet.

This is the code of the macro:

```
Sub HyperlinkedSheetList()
    Dim ws As Worksheet
    Dim i As Integer
    On Error Resume Next
    i = 2
    userreply = MsgBox("This macro delete the sheet called Sheet List and recreates it with sheet names hyperlinked to Sheets", _
        vbOKCancel, "Alert!")
    If userreply = vbOK Then
        Application.
        DisplayAlerts = False
        ActiveWorkbook.
        Sheets("Sheet List").Delete
        Application.
        DisplayAlerts = True
        Sheets.Add
        Before:=Sheets(1)
        Sheets(1).Name =
        "Sheet List"
        Sheets(1).Cells(1,
        1).Value = "Names of Sheets in
        Workbook"
        For Each ws In
        ActiveWorkbook.Worksheets
            If ws.Name <>
            "Sheet List" Then
```

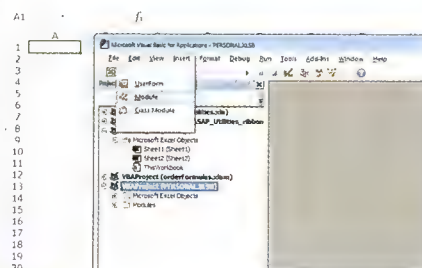
```
ActiveWorkbook.Sheets("Sheet
List").Hyperlinks.Add _
```

```
Anchor:=ActiveWorkbook.
Sheets("Sheet List").Cells(i,
1), _
```

```
Address:="", SubAddress:="" &
ws.Name & "!A1", _
```

```
TextToDisplay:=ws.Name
        i = i + 1
    End If
    Next ws
End If
End Sub
```

A solution like this makes it easier to navigate and use large workbooks. ■

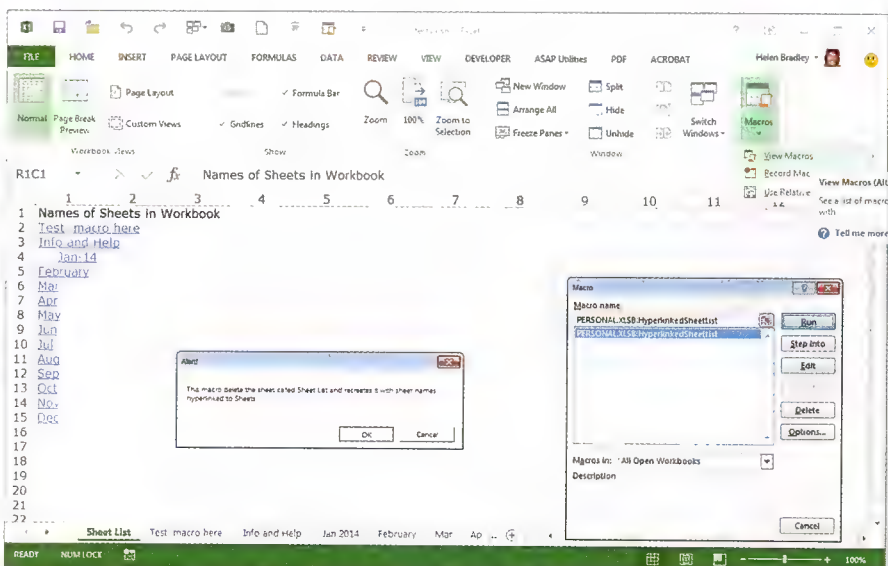
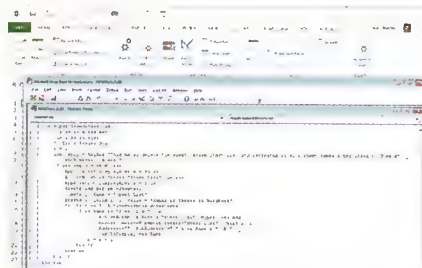


1 INSERT MODULE

This macro can be made available to all workbooks at any time so add it to your Personal.XLSB file. Click the Develop tab in the Ribbon, click Visual Basic and ensure that the VBA Project Window is open. If not click Ctrl-R to open it. Locate and select your Personal.XLSB workbook and click 'Insert > Module'.

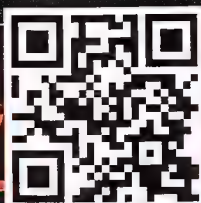
2 ADD THE CODE

The new module will open on the screen. Type the macro code into the module and click Save and then return to Excel. Open a workbook that contains multiple sheets.



3 CREATE THE NEW SHEET LIST

Choose 'View > Macros', select the macro Personal.XLSB!Modulen. HyperlinkedSheetList and click Run. You will be warned any existing sheet called Sheet List will be deleted and it will be removed and added afresh. Then a hyperlinked list of all the other sheets in the workbook will be added to it.



Your One-Stop-Shop for Arduino compatible products & accessories.

XMAS IS HERE, AND SO IS YOUR NEXT PROJECT! PLENTY OF NEW ARRIVALS!

DUAL CHANNEL INFRARED REFLECTANCE SENSOR

A pair of infrared reflectance sensors mounted on one PCB, spaced just the right distance apart to build a line following robot. Easy interface with Arduino. Symmetrical PCB with snapoff holes across the middle, so you can use it as a pair or cut/snap it in half to have two separate reflectance sensors.

- Analogue output shows light or dark surface detected

XC-4261



NEW!

\$12.95

OLED SHIELD

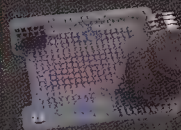
Connect the 128x128 pixel OLED module (XC-4270) to your Arduino using this handy shield, which also provides joystick input and a Piezo module for sound output. Display menus on the screen, use the joystick for selection, and give audible feedback.

- Analogue joystick with push-to-click, great for games or on-screen menus

XC-4269

NEW!

\$29.95



Also available:

OLED Stick
XC-4245 \$12.95

Note: OLED module (XC-4270) sold separately, see bottom of page

BAROMETRIC PRESSURE SENSOR

Highly sensitive barometric pressure sensor for weather, industrial, rocketry, balloon, and many pressure applications. Designed specifically for use as a microaltimeter so it has incredible resolution: so sensitive it can detect an altitude change of just 130mm!

- Operating pressure range 10 to 2000mBar
- I2C interface for easy Arduino connection

XC-4255

NEW!

\$29.95

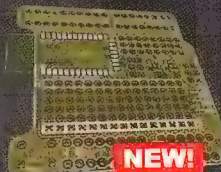


BLUETOOTH SHIELD

Connect your Arduino via Bluetooth® wireless technology for over-the-air reporting, control, and software updates. You can link multiple Arduinos together via Bluetooth®, with one acting as a master and the other as a slave. Pair it with your mobile phone to create a wireless sensor or control device.

- Onboard antenna
- Up to 10 metre range

XC-4259



NEW!

\$39.95

NOW THIS IS A THOUGHTFUL GIFT!

ARDUINO EXPERIMENTER'S KIT

Everything you need to get started with the exciting new world of Arduino. Kit includes "Eleven" Arduino compatible board, servo motor, lights, switches, breadboard and more. Complete with instructions, supporting web page and software examples on fun and educational projects. Perfect pastime for this holiday season!



\$89.95

- No soldering required
- Supplied in a presentation box
- Size: 340(W) x 165(H) x 36(D)mm

XC-4262

Wide range of accessories also available including multimeters, headers, breadboards, leads, resistors, enclosures, Arduino books, etc. More details on our website.

ARDUINO ESSENTIALS

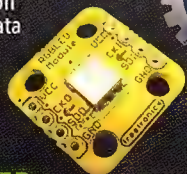
VISIT OUR WEBSITE OR ONE OF OUR MANY STORES TO EXPLORE THE HUGE RANGE

FULL COLOUR RGB LED MODULE

This is an LED with a brain! Includes a bright RGB LED on the top of a board and a WS2801 constant-current, addressable, multi-channel LED driver on the back. This smart module can also be daisy chained.

- 3.3 to 5V operation
- Requires just 2 data connections: clock and data

XC-4234



\$9.95

ICSP PROGRAMMER

Program new applications into a wide range of microcontrollers using this ICSP programmer with a USB interface. Compatible with a wide range of microcontrollers, including all Arduino boards and ATmega328P MCU (ZZ-8726).

- Compatible with Windows, Mac, and Linux
- Supplied with a USB cable and ISP programming cable

XC-4237



\$24.95

Also available:

ATmega328P MCU
ZZ-8726 \$9.95

LARGE DOT MATRIX DISPLAY PANELS

This large, bright 512 LED matrix panel has onboard controller circuitry designed to make it easy to use straight from your board.

- 32 x 16 high brightness LEDs on 10mm pitch
- Viewable over 12 metres away

Available in 2 models:

Red LED Display XC-4250 \$39.95
Blue LED Display XC-4251 \$89.95

Note: Can shown for comparison



from \$39.95

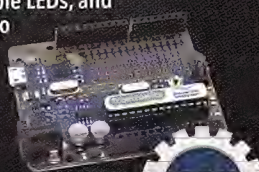
ELEVEN BOARD

100% Arduino compatible. Based on Arduino Uno but with improvements. Top spec ATmega328P Microcontroller, independent prototyping area, visible LEDs, and Micro-USB connector to power from most cellphone chargers! Includes USB cable and guide sheet.

XC-4210

Also available:

ProtoShield Basic XC-4214 \$4.45



\$39.95

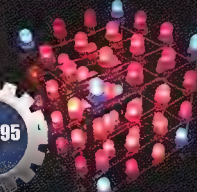
RGB LED 4 x 4 x 4 CUBE KIT

This stunning 3D-matrix of 64 RGB LEDs incorporates an onboard Arduino-compatible controller. Create mesmerising light shows or build your own "ambient device" that gently notifies you of new email or instant messages. Some assembly required.

- Individually addressable 8mm RGB LEDs
- 106mm x 130mm x 106mm (assembled)

XC-4274

\$89.95



128X128 PIXEL OLED DISPLAY MODULE

High resolution, full colour 128x128 pixel OLED module perfect for your display needs including graphics, gauges, graphs and interactive displays.

- 16,384 full colour RGB pixels
- 28.8 x 26.8mm active display area
- Size: 44(W) x 36(H) x 5(D)mm

XC-4270



\$49.95

Arduino Basics #3 – Lighting LEDs

In the third part of this new series, Darren Yates shows you how to connect LEDs to your projects.

One of the best ways of indicating an action or a change in your Android project is to light up a light-emitting diode or LED. These little devices pop up in everything from tablets to phones to notebooks to... you get the point. There are even a few on your Arduino Uno microcontroller board! A diode itself is an electronic component that only allows electrical current to flow in one direction, so a light-emitting diode lights up only when it's connected the right way for current to flow.

VOLTAGE AND POLARITY

Because LEDs must be connected up in a particular way, they're said to have a 'polarity'. LEDs typically have two connection pins – one called the 'anode' (A) and the other called a 'cathode' (K). For electrons to flow through an LED and light it up, we need to connect the anode to a voltage more positive than the cathode. The minimum voltage difference varies depending on the colour of the LED – for example, for red LEDs, you need around 1.6-2.0 volts, for blue LEDs, it's roughly 2.6-3.2 volts and for white LEDs, it can be 3.2-3.4 volts.

Voltage polarity on a diode is a bit like 100 people all jammed up against a door trying to open it when it opens towards them – the door can't open and no-one can move. But if you can swap those 100 people to the other side so that the door opens away from them, it'll open easily and they'll move through easily.

There's one problem with LEDs, though – they have no self-control. If you connect an LED directly to a voltage source like a 12V car battery, so many electrons will fly around the circuit that it'll just overheat and melt (actually, it happens so fast that the LED is likely to blow up like a fuse). To provide protection for both the LED and the power source, you need to add in a component called a 'resistor' to limit the current flow (technically, in this operation, it's called a 'current-limiting resistor').

Using Ohm's Law, you can calculate

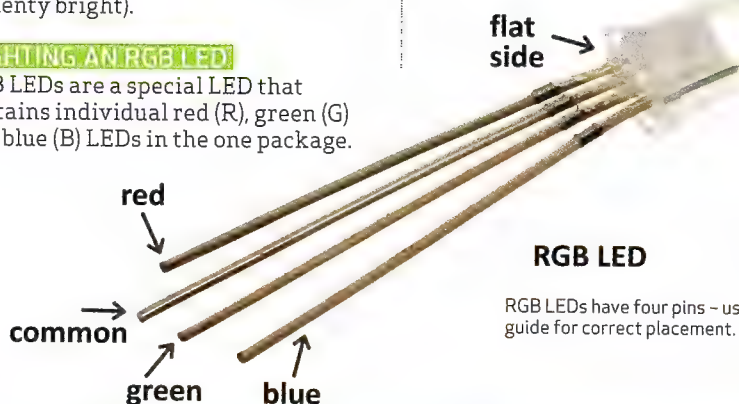
the resistor value quite easily:

$$\begin{aligned} \text{Ohms} &= (\text{supply voltage} \\ &- \text{LED voltage}) / 0.02 \text{ amps} \\ &= (5.0 - 2.0) / 0.02 = 3 / 0.02 = 150 \text{ohms.} \end{aligned}$$

So from that, we know for a red LED, we need a 150ohm resistor to help limit the current to 0.02-amps or 20milliamps (20mA). LEDs are typically rated at 20mA, but at that level, some high-brightness LEDs are as bright as a torch. You can reduce the current by just increasing the value of the resistor. If we increase it to 270ohms, the current drops down to approximately 11mA – and in most cases, that'll still be more than enough current to light any LED quite brightly. Note too that you must substitute the correct colour LED voltage into that equation, but ultimately, don't get too hung up about it – as long as the current flow is less than 20mA, you're still going to get a bright display out of any LED (in fact, in our project, we're using 330-ohm resistors and the light is plenty bright).

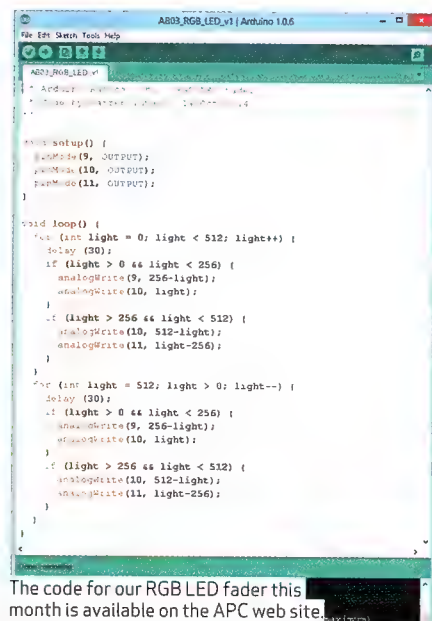
LIGHTING AN RGB LED

RGB LEDs are a special LED that contains individual red (R), green (G) and blue (B) LEDs in the one package.



RGB LED

RGB LEDs have four pins – use this guide for correct placement.



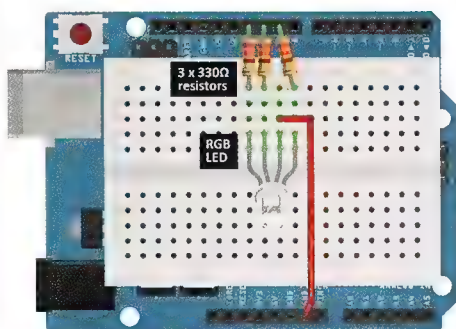
The code for our RGB LED fader this month is available on the APC web site.

By mixing their light in different ratios, you can obtain all the colours of the rainbow. To create this rainbow effect, we need three resistors, one for each of those individual LEDs. RGB LEDs have four pins – an anode for each LED and a common cathode. We drive each anode using three I/O pins of our Arduino Uno microcontroller connected via a resistor and use code to vary the output.

But to vary a digital output, which normally has just two levels – high (digital-1) and low (digital-0), we need to use the Arduino's special I/O ports designated as 'PWM' or 'pulse-width modulated' outputs.

Pulse-width modulation

PWM is a super-cool technique that enables a digital output with only two levels – '1' and '0' – to simulate an analog voltage that can have an infinite number of values. It works like this – if we set the output to rapidly switch between high and low at equal intervals, the average value is half or 0.5. If the output is '1' for 75% of the time and '0' the rest, the average value is 0.75. The Arduino circuitry gives us 256 possible PWM voltage steps.



RGB LED FADER - OVERLAY DIAGRAM

Use this overlay diagram to wire up your RGB LED project.

DIY SHIELD

To build our circuit, we're using a low-cost DIY expansion board or 'shield' as they're known in Arduino circles, which you can buy from eBay and other places for under £10. It plugs into the two rows of expansion pins on the Arduino board. It also comes with a tiny reusable circuit or 'bread board' you can plug components into. Follow the wiring diagram we've included here and note the polarity of the LED – it has a flat on one side to help orientate it. It's easy to build and shouldn't take you more than a few minutes.

You can also use an ordinary electronics breadboard available from stores like Jaycar and add wires from the D9, D10 and D11 pins to the resistors.

FLASH THE ARDUINO BOARD

Once the circuit is built (and you've checked that it's correct), you need to flash the source code to your Arduino Uno board. First, grab hold of the project source code from our web site at apcmag.com/magstuff.htm.

A standard LED has two pins, an anode and a cathode.

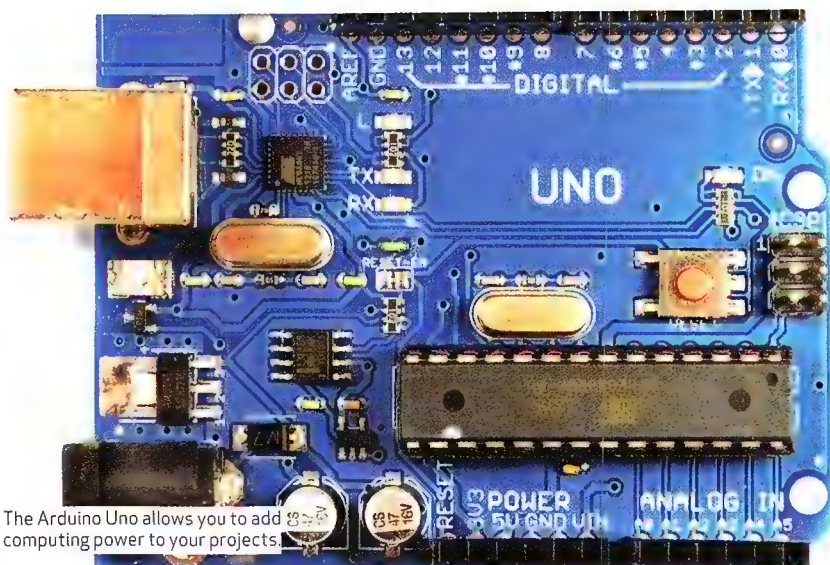


Flat edge

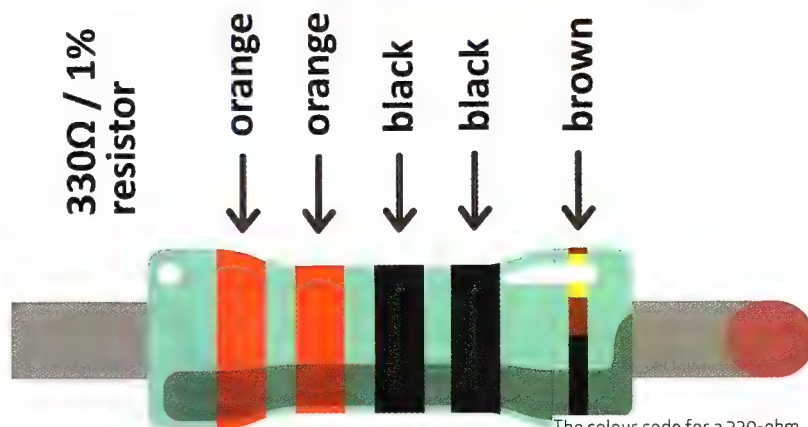
5mm LED

Anode (A)

Cathode (K)



The Arduino Uno allows you to add computing power to your projects.

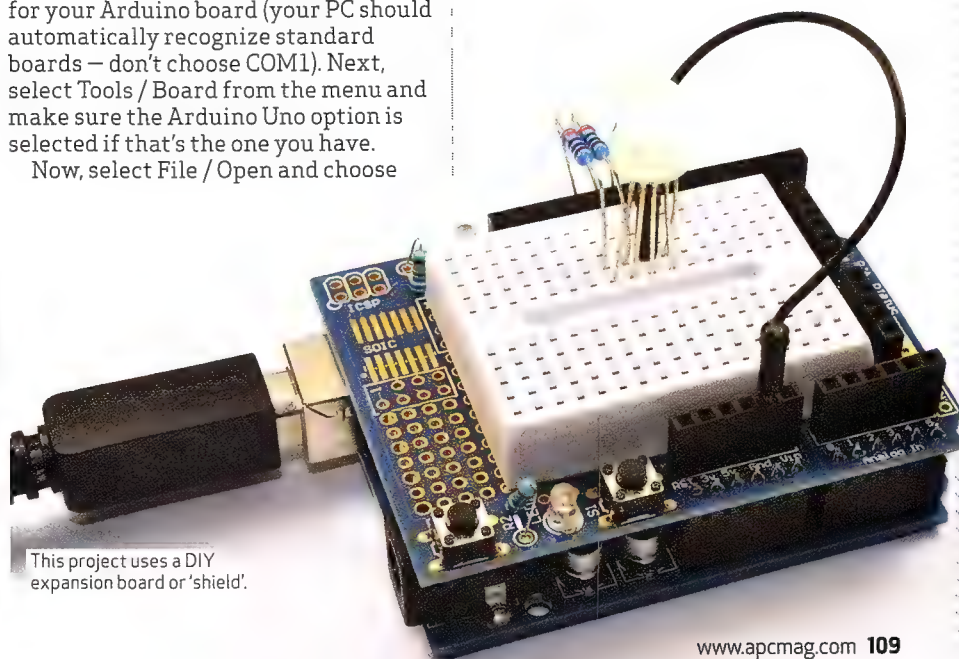


The colour code for a 330-ohm 1% tolerance resistor.

You'll also need to download the Arduino IDE version 1.0.6 from arduino.cc/en/Main/Software (choose the Windows Installer version to make installation easier). Once installed, plug your Arduino Uno board into your PC's USB port and fire up the Arduino IDE. From the menu, select Tools / Serial Port and choose the one for your Arduino Uno board (your PC should automatically recognize standard boards – don't choose COM1). Next, select Tools / Board from the menu and make sure the Arduino Uno option is selected if that's the one you have.

Now, select File / Open and choose

the .ino file from the source code file from our web site. Finally, choose File / Upload to compile the code and flash it to your board. Once the flashing is complete, the RGB LED should automatically start fading between red, green and blue colours. ■



This project uses a DIY expansion board or 'shield'.

Build a dual-core PC for under \$50

The Raspberry Pi gets all the kudos, but there are better value options. Darren Yates explains.



This STB mini PC has a dual-core CPU, Ethernet and HDMI out for under \$50.

I'm happy to admit I love the Raspberry Pi. We first covered the tiny single-board computer (SBC) within the pages of APC back in 2012, not long after it first hit the market. I even developed a Linux operating system designed for the Pi called 'APC PiLinux' just before Raspbian OS hit the scene. The Pi is a great low-cost choice for DIY or embedded applications and its original intended use – education. But as the basis of a media centre, I must admit I'm more than a little surprised that it's still getting so much air-time.

The specs of the Raspberry Pi – even the latest top-drawer Model B+ – aren't spectacular by any stretch. Broadcom's BCM2835 media applications processor is built around an old ARM1176JZ-F single-core engine clocking in at 700MHz and with 512MB of RAM are serviceable, but not overly generous. Again, for its original education focus, the Pi still fits the bill nicely. But while its general-purpose application performance isn't going to worry Intel or AMD, the icing on the cake for media enthusiasts is the built-in VideoCore IV engine that delivers H.264 (and MPEG-2) video playback at up to 1080p resolution and 30fps.

Not to mention the Pi's legendary extremely low price.

LOW-COST ALTERNATIVES AVAILABLE

In the UK and US, a good deal of the Pi's following comes from that low US\$25 price tag for the stripped-down Model A version (US\$35 for the Model B/B+). But in Australia, local distributor, Element 14, encourages personal shoppers to buy through a list of local resellers, where the Pi B+ sells for closer to \$50. At that price, it's still a decent little SBC, but it must be said – it's not the only similarly-priced tool in the shed.

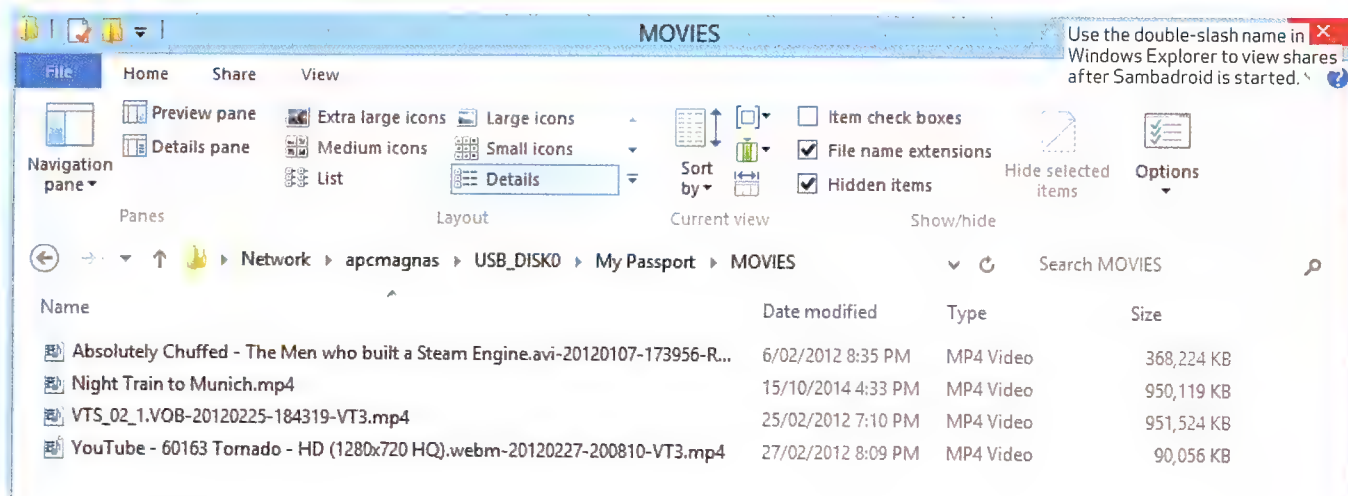
Around the same time the Pi launched in the UK back in 2012, we began seeing the arrival of compact USB-stick mini PCs from Asia. These tiny little computers typically featured a faster 1GHz single-core ARM Cortex A8 CPU, either 512MB or 1GB of RAM, up to 8GB of on-board flash, powered by Android 4.0/Ice Cream Sandwich OS. Throw in at least one USB host port, HDMI and you had a super-compact Android PC. They even came with a case!

Since then, the mini PC market has boomed, although more obviously in Asia. Personally, I still find it astonishing that these little devices haven't found more of a home in the mainstream. Today, you can pick up a dual-core mini PC with Wi-Fi, Bluetooth and Android 4.2/Jelly Bean for under \$40 on eBay. They're essentially a budget Android tablet without the battery or screen – and

compared with the Raspberry Pi, you're getting considerably more horsepower.

The USB-stick styled MK808B is one of the cheapest options now, featuring Rockchip's RK3066 dual-core Cortex A9 CPU clocking in at 1.6GHz. This is an impressive little chip that also packs in ARM's quad-core Mali400MP4 GPU. It's roughly on par with a Samsung Galaxy S2 smartphone for performance – not 'blink and you'll miss it' type stuff, but it won't have the grass growing under it, either. There are a few variations of the MK808B floating around, but the best version has 802.11n Wi-Fi and Bluetooth 4.0, along with Android 4.2/Jelly Bean OS, 1GB of RAM and 8GB of on-board flash. The MicroSD card can handle up to 32GB and it has two USB ports – one Type A and another as OTG, not to mention HDMI output. Look hard on eBay and you'll see a couple of sellers flogging it for under \$40.

Interestingly, it's not the only alternative either. The USB stick-style mini PC isn't a bad option, but can be a little awkward on a desktop. The alternative is the TV set-top box (STB) style that looks more like a Western Digital WDTV Live media player, but with extra versatility. This style of mini PC has been around for a while, too, and prices on entry-level models have recently dropped down to below the US\$40 mark. The benefit here is that you still get the usual HDMI and 802.11n Wi-Fi options, but in addition,



you can usually count on two USB host ports (ideal for keyboard and mouse without needing a hub), composite video output, optical S/PDIF audio and wired Ethernet. Plus, Android 4.2/Jelly Bean OS.

The drawback? The cheaper models typically only include Allwinner's 1GHz A20 CPU — it's dual-cored but based on ARM's less-powerful Cortex A7. However, compared with the Raspberry Pi, it's still out in front.

QUAD-CORE AND BEYOND

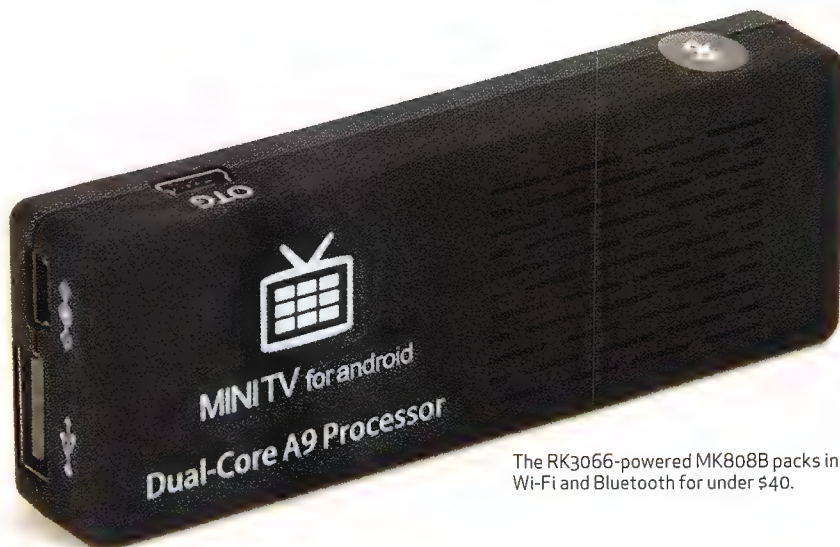
Beyond the dual-core offerings, quad-core models now regularly sell for under US\$60. At this price, they're almost universally powered by Rockchip's quad-core RK3188 ARM Cortex A9 CPU. Initial batches of some mini PCs with this CPU saw user complaints regarding performance issues, but later user-install firmware updates appear to have fixed most concerns.

If four cores aren't enough for you, Allwinner has just announced a new A83T eight-core Cortex A7 CPU design with built-in PowerVR SGX544 GPU. As impressive as that sounds, keep an eye on Rockchip's RK3288 CPU — it's based on the brand-new Cortex A17 core design from ARM, hitting 1.8GHz and including ARM's equally-new MaliT764 GPU. The Cortex A17 is 60% faster, clock for clock, than the Cortex A9 straight off the bat, says ARM, which isn't a bad place to start. It's now appearing in new Android-powered STB mini PCs this side of \$100 on eBay.

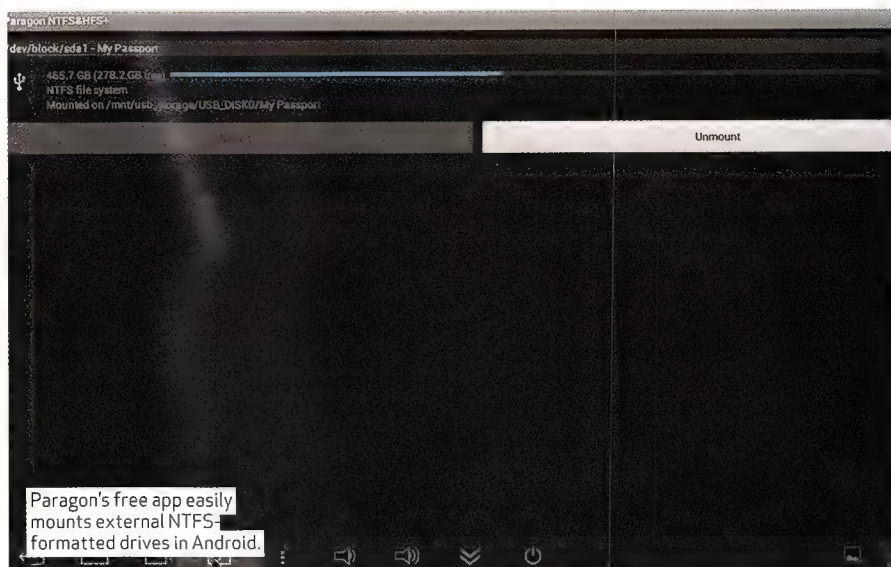
MINI PC HACKING

Firmware updating or hacking of mini PCs is a popular community sport these days. Sites like FreakTab (www.freaktab.com) regularly feature updated Android firmware for various devices that either fixes bugs or even improves upon the official ROMs. The install process typically involves loading the firmware onto a MicroSD card, installing the card into the mini

This hub goes by different names and drives my Android mini PC wireless NAS.



The RK3066-powered MK808B packs in Wi-Fi and Bluetooth for under \$40.



PC and rebooting it into recovery mode, where the firmware basically installs itself. That said, the firmware flashing routine is different for every device, so do your own research before you bite the bullet and have a go yourself. But from first-hand experience, upgrading to an improved ROM can make a significant difference to a mini PC.

While most ROMs are Android-based, there are an increasing number of Linux ROMs now appearing. Linux has supported ARM CPUs for some time now and a number of mini PCs now support ARM-versions of standard Linux distros. You'll find major distros such as Debian and Ubuntu also have repository support for ARM builds. That essentially turns an ARM-class mini PC into a genuine desktop replacement — and for well under \$100. For example, mini PCs powered by Rockchip's RK3188 quad-core CPU can now boot Ubuntu 12.04 LTS via a MicroSD card. What's more, it doesn't interfere with the on-board Android ROM. Plug the card in and reboot to

launch Ubuntu, remove it and reboot to launch Android — it doesn't get much easier than that. Read more at tinyurl.com/kuztlr9.

While Linux will run on these devices, there has been a problem with a lack of device drivers, particularly to handle the ARM Mali400 GPU. However, in recent weeks, this situation has improved and although still very new, it looks as though accelerated GPU support for devices running Rockchip's RK3188 CPU and Linux is now available. Head to www.linuxium.com.au for details.

MINI PC WIRELESS NAS

Since these mini PCs all come with Google Play, they'll run the vast majority of apps available on the app store, but there's an amazingly diverse range of apps that are well suited to mini PC use.

One of my favourites is turning a mini PC into a wireless NAS — and it's not as silly an idea as it might sound. Commercial network-attached storage



WD's USB3.0 Passport drive plugs into the mini PC via the powered hub.



Rockchip's quad-core RK3188 CPU is a popular choice amongst mini PCs.

boxes from the likes of Synology and Qnap are powered by a similar (and sometimes, slower) grade of CPU. For example, Synology's current single-drive DS112j runs a 1GHz version of Marvell's single-core Kirkwood-series chip, based on the old ARMv5-TE architecture (by contrast, the Cortex A9 is a newer ARMv7-A form).

Over the last couple of years, the majority of the mini PCs I've tested, used and mucked around with have root-access already baked in and for creating a wireless NAS, that helps immensely. Sure, a NAS build of this type obviously won't include RAID support, but it should match most single-drive NAS boxes (and possibly even go past them!).

BUILDING UP THE NAS

Starting with a mini PC and even adding a 32GB microSD card, you're not going to have more than 50GB total to play with, so what's needed is a way to bulk up that storage – ideally, using a compact portable hard drive.

And the trick is to use a good-quality

powered USB hub, preferably one that's USB3.0-ready – not necessarily for the speed, but for the extra power handling. Mini PCs are mostly USB2.0 but generally can't supply enough power on their own to run a bus-powered portable drive and too many budget powered hubs I've come across are bundled with lame 5V/1A power bricks that might be fine for a keyboard and mouse, but hopeless for powering a portable drive.

Of course, if you have an externally powered hard drive, that should solve the problem, albeit with a larger footprint.

NAS SOFTWARE

Turning an Android device into a server of any kind does sound weird, but there's a surprising amount of server-functionality software on Google Play to make it happen.

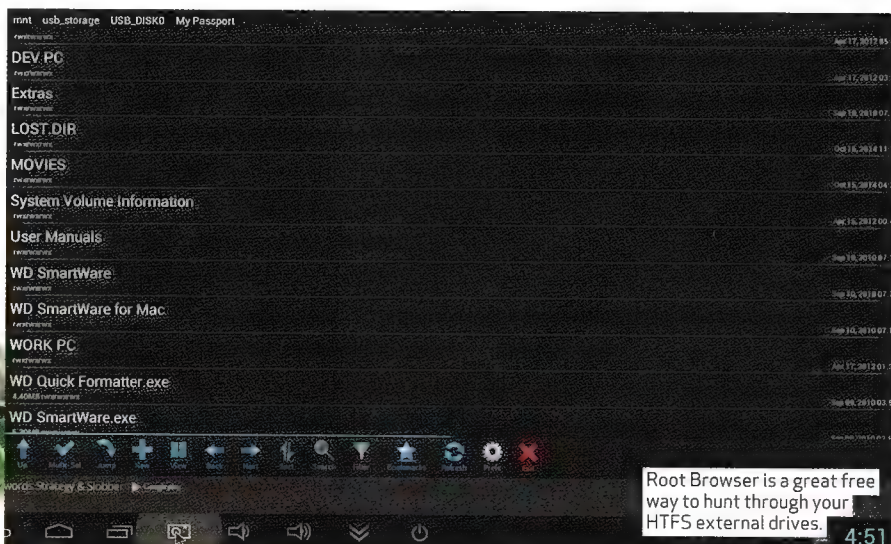
A NAS box is primarily about storage and one of the simplest apps I've seen for turning an Android device into a network storage server is Samba Filesharing. Samba is the Linux tool for

network communications with Microsoft Windows and here, it enables a mini PC to appear as a shared network storage drive on Windows Explorer. Samba Filesharing is free, but it does have a couple of drawbacks – apart from needing root access, it can only support two storage devices (internal storage and one secondary external source) and that second partition can only be FAT-formatted, which limits its usefulness.

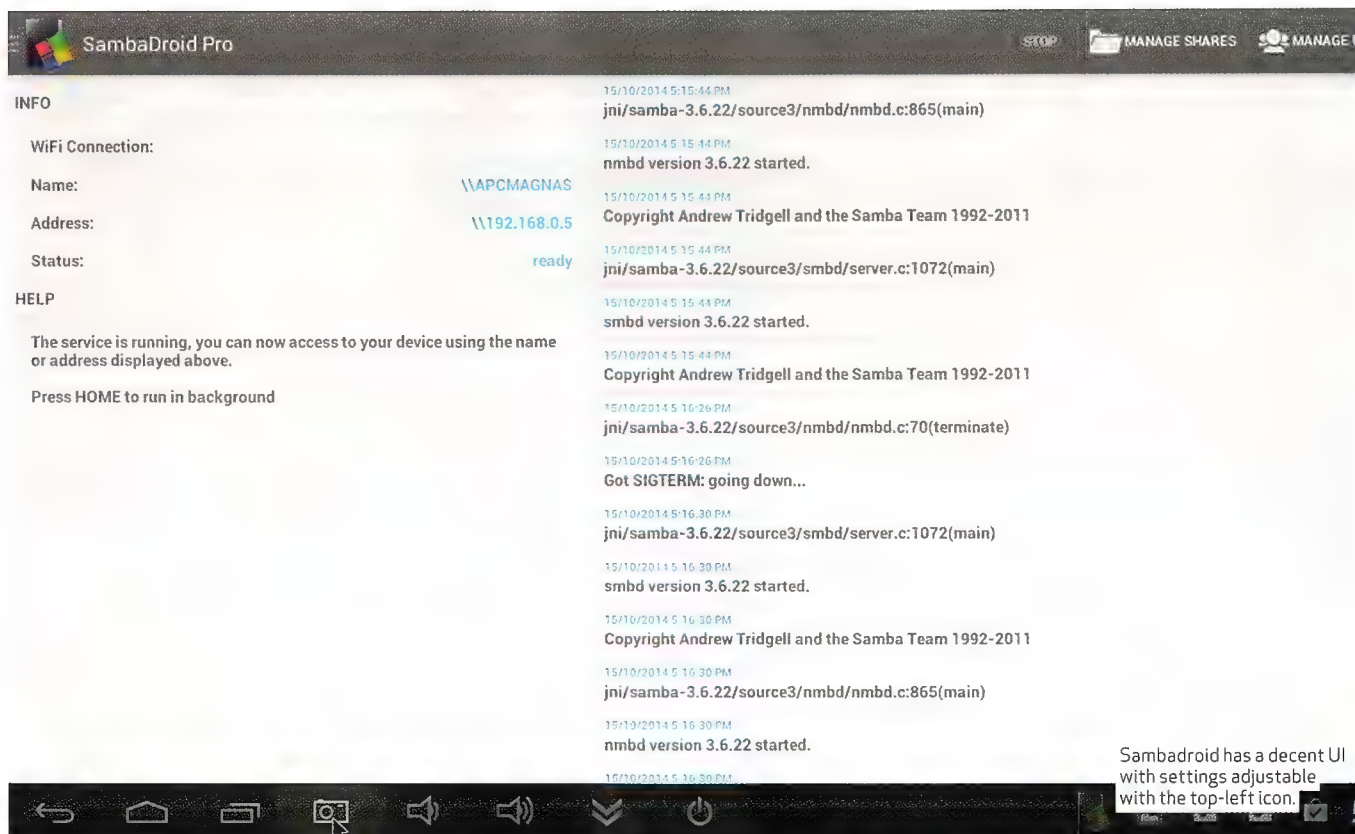
However, if you're prepared to cough up \$2, there is an excellent alternative on Google Play called Smbadroid (tinyurl.com/smbadroid). It's free to download, but this free version only gives you network access to your Android device's internal storage. Upgrade to the Pro version via a \$2 in-app purchase and you can add in external storage options. There's only one minor hitch – early versions of Android don't support Microsoft NTFS-partitioned devices. But again, there's a quick fix for this too – grab Paragon's exFAT, NTFS and HFS mounting app, free on Google Play



My Raspberry Pi Model B with custom heatsink for overclocking to 1GHz.



Root Browser is a great free way to hunt through your HTFS external drives.



Buyer beware

Since these devices are usually manufactured and sold by small no-name companies and retailers, don't expect the level of support you'd get buying a \$1,000 PC. Like most things, you get what you pay for. That's not to say mini PCs aren't worth the effort — on the contrary. It just means you need to be prepared for some DIY and search out your own solutions to problems (the mini PC community is a great resource).

The other thing we'd stress is that if you buy a mini PC from eBay, you may end up with a US or EU-plugged power brick. Even if you're supplied an Australian-plugged brick, for safety, we'd recommend replacing it with a local Australian-approved power supply unit.

Mini PCs using USB power can be juiced with any USB power adapter with a two-amp (2A) current rating. But for mini PCs using a brick that terminates with a barrel-type DC power connector, look for a multi-adapter plug brick rated to the same voltage, current and plug polarity as the original. You can usually find these at Jaycar Electronics stores.

(tinyurl.com/ok5mj5y). This app happily mounts NTFS-formatted drives within Android that you can then add as shares to Sambadroid.

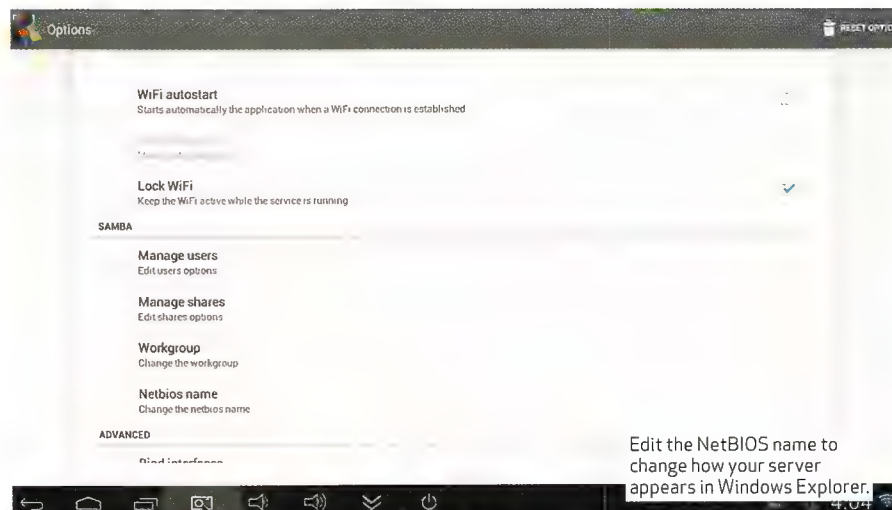
FINDING SAMBADROID ON WINDOWS

The only minor annoyance we've found with Sambadroid is that it won't automatically appear in Windows Explorer the way Samba Filesharing does (at least not with Windows 8.1). But all you need to do is fire up Windows Explorer and in the address/folder bar, type in '\\sambadroid' (assuming you haven't changed the name in the app settings, in which case, you replace 'sambadroid' with your

chosen NetBIOS name) and the shares should quickly appear.

While we're assuming you'll use this safely behind a firewall/NAT router, Sambadroid does have support for users and passwords to boost security if that's an issue for you.

Still, the end-result is you can have a mini PC with a 500GB or larger hard drive connected via a powered USB hub and acting as a wireless NAS box. You won't get RAID support through Android, but unlike most other NAS boxes, you'll also end up with a general-purpose Android PC with access to over one million apps in Google Play that can play games, movies — even do real work. ■



Part 3 – If this, then that; otherwise something else

In the third part of this series, Darren Yates explains how to make selections using the classic if-else statement.



Can you get through the day without one of these in the morning?

Think about the number of choices you make every day – actually, forget that, just think about the choices involved in getting your morning coffee! Do you go for a latte, a flat white or just a short black? Do you get full-cream 'leaded' milk, skim or – ahem – soy? Do you choose a small, regular or large?

One of the most important features of coding is the ability to direct code action based on user choice or 'feedback'. So far in our coding masterclass, the apps we've coded have been essentially 'top down' – every line of code is processed from top to bottom, literally, no 'ifs' or 'buts'. And that's fine, but what if we wanted to code this coffee choice example? Without some way of being able to choose different actions, everyone simply ends up with a latte flat-white short-black with full-cream, skim and soy milk. Sound delicious doesn't it!

IFTTT

One of the really cool social network services on the web is If This Then That (IFTTT). If you haven't used it yet, head to ifttt.com. It allows you to use a range of products and social media services as an event or 'trigger' to launch a function or 'action'. For example, if the weather channel says it's going to rain in Sydney tomorrow, I can have IFTTT automatically send me a notification to my Android phone. It's an ultra-modern take on an old programming concept called selection – allowing your programs to make selections based on some input. Every language has an 'if' style code statement and Java is no different. Here's the basic form:

```
if ( boolean-expression ) {
    code-statements;
}
```

In other words, if the code inside the brackets '(...)' is true, perform the code statements inside the following braces '}' (called a 'code block'). Otherwise, skip them and perform the next code statement after the closing brace '}'.

BOOLEAN EXPRESSION, COMPARISON OPERATORS

A boolean expression is a mathematical function that evaluates to either true or false. For example, '5 is greater 3' is true, '3 is greater than 5' is false and so is '5 is less than 3'.

In coding, we use the mathematical short-forms for 'greater than' and 'less than' called comparison operators. Java has six basic comparison operators: > (greater than), < (less than), == (equal to), != (not equal to), >= (greater than or equal to), <= (less than or equal to).

So in our examples, '5 is greater than

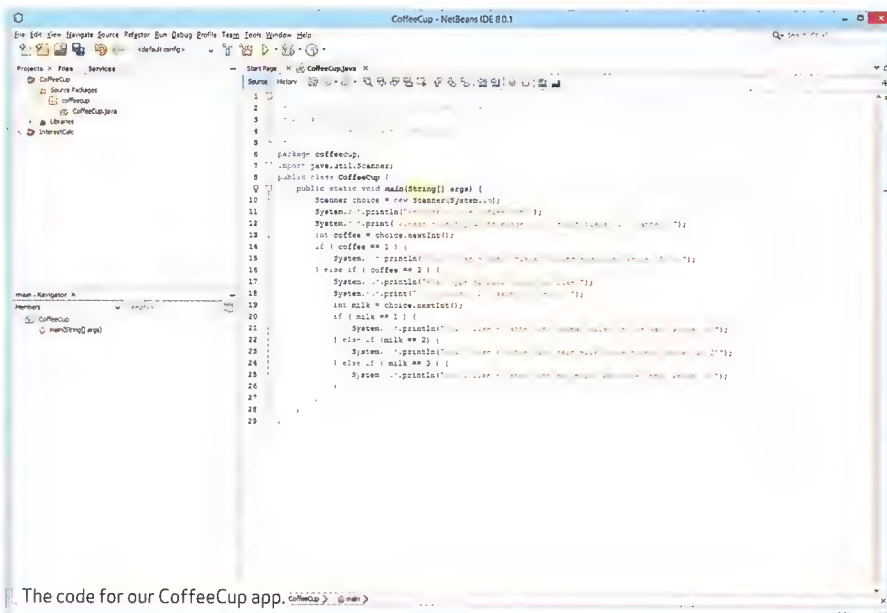
3' becomes '5 > 3'; '3 is less than 5' would be expressed as '3 < 5'. You can go further and make mathematical equations as part of boolean expressions, for example, '5 x 3 >= 12' would equate to being true while '3 x 4 >= 7 x 5' would be false.

LOGICAL OPERATORS

But you can also combine boolean expressions together using Java's logical operators – && (AND), || (OR), ! (NOT) and ^ (exclusive-OR). Logical operators form the functionality of a huge branch of mathematics called

```
if ( coffee == 1 ) {
    System.out.println("You'd like a short black. Coming right up! Price: $3.80");
} else if ( coffee == 2 ) {
    System.out.println("What type of milk would you like?");
    System.out.print("(1 - normal, 2 - skim, 3 - soy): ");
    int milk = choice.nextInt();
    if ( milk == 1 ) {
        System.out.println("You'd like a latte with normal milk! On its way! Price: $4");
    } else if ( milk == 2 ) {
        System.out.println("You'd like a latte with skim milk! Sure thing! Price: $4.25");
    } else if ( milk == 3 ) {
        System.out.println("You'd like a latte with soy milk! Won't be long! Price: $7");
    }
}
```

The if-else statement block is the crux of our app this month.



Output - CoffeeCup (run) X






```

run:
Welcome to the Coffee Cup!
Please select your beverage: (1 - short black, 2 - latte): 2
What type of milk would you like?
(1 - normal, 2 - skim, 3 - soy): 3
You'd like a latte with soy milk! Won't be long! Price: $7
BUILD SUCCESSFUL (total time: 30 seconds)

```

Choose a latte and the code then asks you for a choice of milk.

'boolean algebra' that's used heavily in advanced digital electronics and computing. But they're also just written representations of concepts you use in everyday life without even thinking about it — let's go back to our bleary-eyed barista who has to know how to make the millions of different coffee combinations customers can choose from. A simple example in pseudo-code (half-English, half-code) could look like:

```

if coffee = 'short black',
don't add any milk
if coffee = 'latte' AND milk
choice = 'cow', add cow milk
if coffee = 'latte' AND milk
choice = 'skim', add skim milk
if coffee = 'latte' AND milk
choice = 'soy', add soy milk

```

For the barista to get the soy milk out of the fridge, the customer's coffee choice has to be a latte and the customer has to ask for soy milk — both of those statements have to be true. And that's the definition of an AND expression — the output or conjunction of the two statements or operands is true only if both operands are true.

The OR expression is slightly different — if either one of the operands is true, the result is true.

For example, if the coffee choice is a 'latte' or a 'flat white', the barista will have to ask the customer what type of milk they want. Again, using pseudo-code, this would look something like:

```

if coffee = 'latte' OR coffee
= 'flatwhite', ask for milk
type

```

Looking back at that first group of statements, there's a fair amount of repetition there, particularly involving checking if the choice of coffee is 'latte'. There is a more efficient way we can code this, again in pseudo-code:

```

if coffee = shortblack, don't
add any milk,
else, if coffee = latte, then
if milk choice = cow, add cow
milk,
else, if milk choice = skim,
add skim milk,
else, if milk choice = soy,
add soy milk.

```

It looks a bit more complex but we've cut down the number of boolean comparisons from seven to five. Look back at that first set of statements and count up the equal '=' signs — each one represents a comparison we're asking the computer CPU to process. We have



seven comparisons — one 'coffee = short black', three 'coffee = latte' and three for 'milk choice' (cow, skim and soy milk).

But in the second set just above, we only have five — we check for short black once, latte once and the three milk types. Why is that important? Because the code is more efficient. Code efficiency matters for several reasons. The first is speed. The fewer comparisons we have to perform, the faster our app runs. Now you won't see the difference in a simple app like we have here, but as you start building more and more complex apps, the speed of operation could well be an important issue.

Second, good code efficiency helps to maximize battery life — the more efficient your code, the less work the CPU has to do and that reduces the load on the battery. And since Java is the nuts and bolts behind Android apps, it's an important issue worth considering.

Yet another reason is code maintenance. If for some reason you need to later change the coffee choice from 'latte' to something else, the original code requires you edit it three times, yet the new option only once — and that'll help reduce the chances of introducing new errors into your app.

Output - CoffeeCup (run) X






```

run:
Welcome to the Coffee Cup!
Please select your beverage: (1 - short black, 2 - latte): 1
You'd like a short black. Coming right up! Price: $3.80
BUILD SUCCESSFUL (total time: 1 second)

```

Choose a short black coffee and the code doesn't ask you about milk.

Don't think that's important? Both the recent Shellshock and Heartbleed bugs were the result of coding errors.

Java lets us compress the number of comparisons down, thanks to the 'else' clause.

THE ELSE CLAUSE

Whereas the standard if-conditional statement only executes the following statement code-block if the if-condition is true, including the 'else' clause gives you the added option of executing other statements if that if-condition is false. In Java, it looks like this:

```
if ( boolean/logical-  
expression ) {  
    true-condition-  
statement(s);  
} else {  
    false-condition-  
statement(s);
```

So, as a practical example, we could write the following code to determine if someone is old enough to vote:

```
if ( age >= 18 ) {  
    System.out.println("You're  
old enough to vote!");
```

Logical Operators

Function

AND

OR

Exclusive-OR

NOT

Code

&&

||

^

!

Logical and comparison operators are a key part of the if-else statement.

Comparison Operators

Function

less than

greater than

equal to

not equal to

less than or equal to

greater than or equal to

Code

<

>

=

!=

<=

>=

```
} else {  
    System.out.println("Sorry,  
you're too young.");
```

Here, if a person's age is greater than or equal to 18 (age >= 18), they're told they can vote. Otherwise (else), the person's age is less than 18, the person is too young to vote and is notified via console accordingly.

Using the else clause can be a real timesaver, but you must clearly understand the logic of your boolean expression(s), otherwise your app may not behave the way you expect.

NESTING IF-ELSE STATEMENTS

Look back at our if-else statements choosing the coffee type and you can see we're linking if statements for the milk choice inside the 'coffee = latte' if-else statement, shown by the indentation — this type of linking is called 'nesting' and it's a powerful tool in a coder's armoury. Indenting the codelines inside the curly braces is another coding convention and by doing this consistently, you'll find it a lot easier to follow the flow of and understand your code.

To see how this all works, let's get and write some code!

APP #3 — THE COFFEE CUP

A new coffee shop called the 'Coffee Cup' is about to open, where customers choose their coffee using computer kiosk-style terminals and make their order. Once the order is completed, it's sent to the baristas to make and the customer knows exactly how much it'll cost. You've been given the task of writing the kiosk code. Now this coffee shop only serves two kinds of coffee — short black and latte. But it does serve three kinds of milk — normal, skim and soy.

Combining what we've learned so far over the first three parts of this series, we have enough toys in the toolbox to write a basic but functional version of this app.

Again, we start by launching the NetBeans IDE and from the menu, selecting File/New Project. Make sure 'Java Application' is the Projects type selected, press the Next button, change the Project name on the new screen to 'CoffeeCup' and press Finish.

IPO

Remember last time, we talked briefly about IPO — input, process, output? The same coding model also works here. We need to ask the user



Kiosk computers follow the classic IPO (input/process/output) coding model.

for information (what coffee choices they want), process that info (set the coffee order) and output confirmation back to the user. So, again, we'll start with the Scanner class we learned about last time to read user input from the keyboard with the codeline:

```
Scanner input = new scanner
(System.in);
```

After that, we'll greet the user and ask them for the beverage type. To make it easier for coding, we'll ask them to enter a '1' for short black and '2' for a latte. That data is then stored in an integer variable called 'coffee' using the codeline:

```
int coffee = input.
nextInt();
```

Note: when declaring a primitive datatype variable like an integer (int), it starts with a lower-case 'i'.

IF-ELSE STATEMENTS

Now we're up to giving our new if-else statement a run. The first thing we need to check for is whether the user asked for a short black or not. Since we've told the user to enter a '1' for short black, we can check this simply by testing whether the value in the coffee variable is equal to one:

```
if ( coffee == 1 ) {
    System.out.println("You'd
like a short black. Coming
right up! Price: $3.50");
}
```

But we also have to check if the choice was a latte. If the customer asks for a latte, in coding-speak it means the expression 'customer wants short-black' is false, which means we should bring in the 'else' clause:

```
if ( coffee == 1 ) {
    System.out.println("You'd
like a short black. Coming
right up! Price: $3.50");
} else if ( coffee == 2 ) {
    System.out.println("What
milk would you like?");
    System.out.println("(1-
normal, 2-skim, 3-soy): ");
}
```

Now strictly speaking, since the Coffee Cup coffee shop only offers two types of coffee, we don't really need to also check if the coffee choice was a latte (coffee == 2). If it wasn't a short black, we could assume it's a latte because it can't be anything else (unless, of course, the customer decides to just walk out). But if we expand the coffee offerings in the future, you can't make that simple assumption, so it's important to see

Create a new project in NetBeans and call it 'Coffee Cup'.

how the else clause works. And notice, we've linked or 'chained' if-else statements together – the else clause is immediately followed by another if statement (coffee == 2). This is what's called a 'multi-way' if-else statement.

Further down, we use this 'latte' choice to then ask the user about the type of milk they'd like. Here, we now use 'nested' if statements to decide the output based on that milk choice. So really, there are multiple ways you can use if-else statements.

The most important tip I can give is make sure that you surround each code block with opening '{' and closing '}' braces. If you don't, you'll end up with syntax errors and your code won't compile. Using consistent code indentation will help prevent this.

YOUR TURN

Now, it's your turn – play around with the CoffeeCup app, change the code and

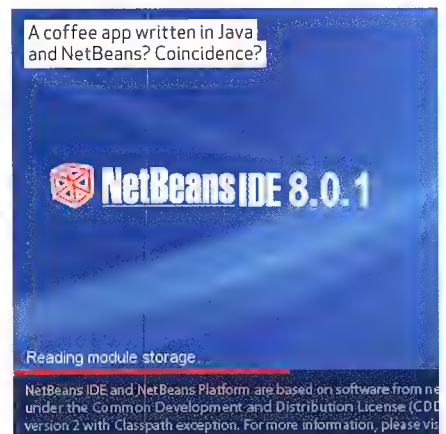
see what happens. The best way to improve your coding ability is practice – the more you code, the better you become at it. Don't worry about making mistakes – just learn from them and keep coding.

Right now, the CoffeeCup app works, but given it reflects only what we've covered so far in this masterclass, it's pretty basic and has a few deficiencies. Can you spot any? What about customers wanting to purchase more than one coffee? Is there a way we can tally up the cost of multiple coffees? What about adding other coffee types?

We're making good progress but there are still lots of important coding tools for our toolbox we're yet to cover, so join us again next month. ■

Getting the code

You can grab the source-code for our CoffeeCup app from our web site at apcmag.com/magstuff.htm. If you've just joined us, we're using the Java JDK 8.0 (www.oracle.com/technetwork/java/javase/downloads) and NetBeans 8.01 IDE (netbeans.org/downloads). Install the Java JDK before you install NetBeans — it works much better that way.



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Dragon Age: Inquisition

The biggest game in the series, but is it the best?

The game opens in the village of Haven. It's ten years after the events of *Dragon Age: Origins*, a few weeks after the epilogue of *Dragon Age 2*, and the exact moment that the Temple of Sacred Ashes is destroyed in a sky-tearing blast of unknown origin.

Inside, the head of the Chantry – the world's main religious organisation – was attempting to negotiate peace between the warring Templars and mages. Where the temple once stood, there is now only a dangerous and growing vortex that threatens to engulf the world. You are the only survivor. Who you are, and why you were at the peace talks, depends on the character you create. There are four races to pick from: human, dwarf, elf or hulking grey Qunari. This choice will provide plenty of special dialogue options based on your character's culture and history, but it doesn't affect the setup.

The breach is the story bridge that links the high-level political posturing of the world's factions to your own need to venture out and kill things. Closing it requires power, and that, initially, means securing the support of either the rebel mages or the now autonomous Templars. To approach either, you'll first need to increase the Inquisition's support – by completing quests. Power lets you unlock new areas and progress the story, while Influence unlocks perks, from new conversation options to enhanced lockpicking for your party's rogues.

In terms of the size and scope of the environments, *Dragon Age: Inquisition* is the total opposite of *Dragon Age 2*. Out in the world, there's plenty of busy work to bulk out each zone. Inquisition's sidequests are a variable bunch, and the worst resemble MMO fetch quests. Fortunately, there's plenty of substance too.

The main story missions are filled with tough, world-

shifting decisions. They are, almost without exception, wonderful scenarios. Each mission is distinct, memorable, and significantly moves the story along.

The story also provides Inquisition's few instances of lengthy, linear combat encounters. The combat system has been significantly changed for this incarnation. You still have *Dragon Age*'s classic trio of warrior, rogue and mage – each with multiple skill trees to further define the role. Now, though, the emphasis is on direct attacks, to swipe away at enemies between activation of the skills assigned to your hotbar.

For the most part, it works, but there are persistent minor annoyances. I played as a rogue, and found the combat animations too slow for my liking and targeting enemies can be troublesome, too. Control over the party's tactics – used to assign orders to the party members you're not currently controlling – has been simplified. In

previous games, orders resembled absurd algebra puzzles. In *Inquisition*, you have some agency over when healing items are consumed, but skills can only be enabled, disabled or marked as preferential – giving them priority over other skills.

I miss the fine-tuning the old system enabled. Controlling *Inquisition*'s party requires either accepting the inefficiencies of the AI, or spending a lot of time micro-managing. Choose the latter, and you'll find the tactics battle screen has its own issues, all of which are with the camera. It gives you a top-down view of the battlefield, but is awkward to move and doesn't zoom out quite far enough.

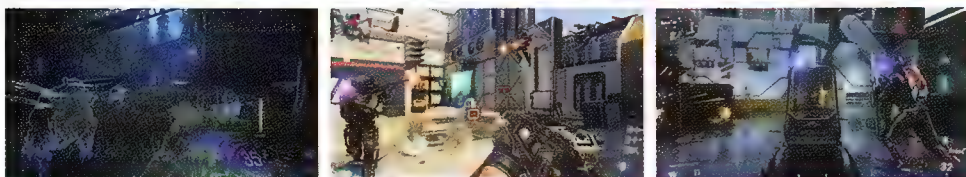
The biggest combat change is in how healing works. Mages can no longer cast restorative spells, and characters don't regenerate health between fights. Instead, your entire party has a shared pool of potions which can only be restocked at the camps you set up out in the world, or from supply caches found scattered along the path of a main mission. It's a decent system, and changes how battles are arranged. For one thing, difficulty is no longer tied to the number of enemies, but rather their composition. Even when fighting three or four bandits, the presence of a shield-carrying Templar can provide a significant challenge.

I love so much of what this game is. The story is something I'm eager to discuss with people as they play through the game – to discover what they did, and learn of the breadth of divergence possible in each person's campaign. More than that, *Inquisition* is filled with moments that make it such a fulfilling and worthy sequel for the series. The heartwarming interactions with those companions I befriended. The brief touches of humour and levity. My first fight with a dragon – the way its animations perfectly conveyed arrogance, annoyance, and eventually exhaustion – will be one of my most enduring gaming memories of this year. ■ Phil Savage

Verdict

A fantastic campaign and massive open environments, soured only slightly by minor, persistent flaws.





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Call of Duty: Advanced Warfare

Suited but not quite rebooted.

Popular wisdom would have it that you can't teach an old COD new tricks; that the formula for six hours of single-player hoohah whizzbangery and twitch-based online shootouts was apparently carved into a stone tablet somewhere at Activision years ago, never to be defied. But *Advanced Warfare*, the first COD not to have Infinity Ward or Treyarch listed in its developer credits since 2004, doesn't care about that stone tablet. It's here to change things. It's here to give you the Exo Suit.

No facetiousness intended here. COD's own version of the Crysus Nanosuit really does change your approach to the game, particularly in online modes. Picture the scene: you're playing Hardpoint, and you need to get to point B, like, yesterday. Double jumping gives you a boost jump, and once up in the air you can boost further forwards still. It's the standard traversal technique in *Advanced Warfare*, but in this situation everyone knows you're coming. A single boost-strafe can save your life, or get you

to the dog tags in time during Kill Confirmed. In the new Uplink multiplayer mode, a twist on traditional CTF in that the flag is a spherical drone dropped at random and the score points are high in the air, a boost jump can also make you feel like Michael Jordan.

Online multiplayer flourishes thanks to Sledgehammer's willingness to splice the COD double-helix with outside influences such as *Team Fortress 2* and, er, a certain mech-based shooter. Single-player doesn't.

No, instead solo play is where those age-old, ironclad *Call Of Duty* conventions begin to frustrate.

What's more, Kevin Spacey. His shark-eyed PMC owner, Irons, adds not just A-list glitz to the plot, but occasional moments of brilliant dramatic execution. Then you're presented with a 'Press button to pay respects' QTE at a military funeral, and the whole house of cards (high five!) falls down.

There's a tremendous amount of experience and talent at Sledgehammer Games in single-player storytelling – many lead devs on this game worked on *Dead Space* – but *Advanced*

Warfare doesn't demonstrate the ceiling of its abilities. Locations lack atmosphere and feel borrowed from previous series entries, and palate cleansers such as the ice caves of Antarctica are few and far between.

Weapon feedback hasn't changed tangibly, which is to say it still feels great, so you've always got that motivating force in the campaign. It's good at changing the pace by introducing lenient stealth bits to soothe your trigger finger after the last big gunfight, but lacks that third dynamic *Ghosts* used so well: silliness.

Great multiplayer, disappointing story. Where *Ghosts* used the oft-derided COD idioms with a knowing smile, *Advanced Warfare* uses them with Kevin Spacey's cold, stern gaze.

■ Phil Iwaniuk

Verdict

Increases the pace still further in online multiplayer to fantastic effect. However, solo play feels a bit safe.



F1 2014

Annual update takes a wrong turn.

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Remember when Super Aguri cobbled together a car built around a creaking Arrows chassis that was probably old enough to buy scratchcards? The one Anthony Davidson lost control of and span off while warming up his tires on the parade lap? Stepping back into *F1 2014*'s ageing infrastructure feels a bit like driving that very same Super Aguri. Perhaps There's no PS4 version this year, but Codemasters promises next year's game will be new-gen and will come earlier in the year. So right now we're stuck with the decrepit Ego engine wheezing along well under 30fps as it renders Lewis and Nico stretching into the distance in their super-Mercs. New Russian and Austrian excursions are included, of course, alongside other changes to reflect reality such as the vacuum cleaner engine noises and reduced turbo engine performances. And that's your lot. No classic car content from last year, let alone any expansion of it. No new modes, and even the wholesale removal of the young driver test that previously introduced you to the game. In its place, a strikingly throwaway single lap challenge of Monza. And then: last year's game, with this year's cars. It's the quintessential 'barely trying' annual sports entry. ■ Phil Iwaniuk



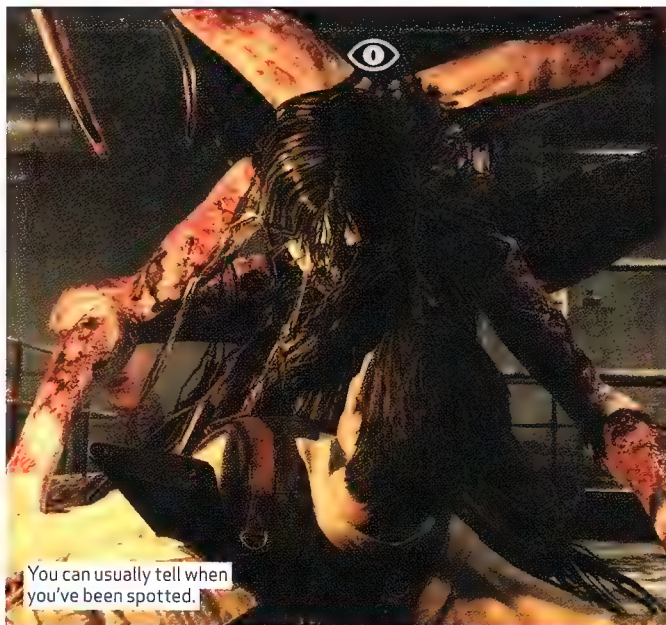
Peggle 2

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Unless you've been nibbling moss in a cave since 2007, you already know how *Peggle* works. In case you have just returned from an extended hermetic spell, these are the broad strokes — you fire balls at orange pegs and attempt to clear them all from the screen before you run out of shots. It's this simple yet oh-so-addictive premise that has made *Peggle* one of the most popular casual games around. Music has always played a key role in *Peggle*'s appeal, and after completing the initial levels with rainbow-farting unicorn Bjorn to a soundtrack of Ode To Joy you'll discover that each new Master has their own classical theme. Every level now includes three optional objectives, such as beating a specific score or achieving a certain number of special shots, and each Master has a set of trials to complete, which not only provide additional challenges but also help you to learn new techniques and skills. With only five *Peggle* Masters to choose from (compared with ten in the original) it does feel like this sequel is a little cut down, and it's disappointing that every time you load the game you are immediately pointed in the direction of the Store to purchase more characters. However, the number of objectives and trials available to beat, combined with several online and local multiplayer modes, are enough to keep even the most seasoned of *Peggle* devotees suitably happy.

■ Iain Wilson



You can usually tell when you've been spotted.

FROM \$68 | PC, PS3, PS4, XBOX ONE, XBOX 360 | WWW.THEEVILWITHIN.COM

The Evil Within

Replacing fear with some questionable design choices.

Halfway through *The Evil Within*, I came across five abandoned wheelchairs in a darkened hospital hallway. To me, this summed up the game's philosophy perfectly. One wheelchair in a hallway would be spooky, but five? That must be five times as spooky, right?

Forget the blood trail on the floor or a handprint on a wall — here comes a river of blood that pulls you down a chute of blood into a chest-high pool of blood.

Unfortunately, a hundred times the gore doesn't produce a hundred times the scares. *The Evil Within* is challenging and tense at times, but in place of terror there's just a ton of grisly gross-outs. If you're looking for horror, you'll find it, but with it, many design flaws.

We start by meeting protagonist Sebastian Castellanos and his fellow detectives who after a few brief moments are whisked off to a hospital where they stand gazing at mutilated bodies. Within minutes the ridiculously named town of Krimsion City is twisting in on itself like a giant Rubik's Cube, and the detective is on

his own, in the dark, surrounded by abominations. Initially, Sebastian's only chance is to employ stealth. Although he has a revolver, there's little ammo to be found, and shooting his shambling foes, even in the head, rarely puts them down for good.

Later, a shotgun and sniper rifle are introduced, and most importantly, a crossbow, which Sebastian can fashion various bolts by disarming traps.

While I didn't find *The Evil Within* scary, I did at times find it tense and exciting. There are areas so dark that even Sebastian's charmingly silly old-timey lantern barely illuminates the gloom, and even knowing full well what you'll find (monsters and traps) it's impossible not to be nervous while exploring.

This is also a very challenging game that has no interest in making things easy for you. While intentionally making things tough is fine, making them more so through restrictive presentation and rotten controls is not. *The Evil Within* forces an aspect ratio of 2.5:1, meaning about 30% of the screen at the top and bottom is covered by black

bars. This makes the awkward follow camera, which is already often stuck directly behind Sebastian's head or body even worse than it already is.

Controlling the detective is a sluggish experience. With the dozens of wheels, valves, and levers he has to activate, getting him close enough and facing the right way is often tricky.

The story can be slowly pieced together through journal pages and recordings found in the usual places, but there's nothing very satisfying to the explanation of why monsters are happening.

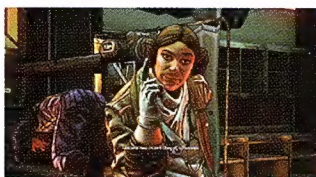
I know that fans of director Shinji Mikami's past work won't want to miss this, but despite some exciting action sequences and enjoyable fights, and a hardcore old-school survival challenge, I'd have a tough time recommending it.

■ Chris Livingston

Verdict

A challenging blend of stealth and action, but it relies on gross-out rather than fear.





\$69 | PC, XBOX360, PS3 | WWW.BORDERLANDSTHEGAME.COM

Borderlands: The Pre-Sequel!

It's a bullet ballet in low gravity.

Borderlands is best when its irreverence is reflected in its combat, when its layering the insanity of its characters atop weird weapons and enemies. Near-weightlessness is a terrific tweak to that formula; launching rockets at vulgar mutants and mechs is just more playful when you (and your co-op teammates) are tilting softly through the air.

The changes to movement bring novelty and a weird gracefulness to *Borderlands'* combat. But otherwise, *The Pre-Sequel* feels like a super-sized mound of *Borderlands 2* DLC. The new setting, classes and weapon types reinvigorate things a bit, but it doesn't deviate much from the feel and format of the last game. It's fun, but very familiar.

The problem with mechanically simple missions is that their fun relies entirely on funny dialogue and interesting firefights, both of which are inconsistent. Combat can be great — one of the first bosses pounces and floats between a bunch of indoor platforms, some of which are

electrified. Chasing him without shocking yourself and fending off his minions was frantic and tough. The last chapter mercilessly throws a variety of jumping, somersaulting, flying, cloaked, ranged, and melee aliens and soldiers at you, alongside enemies that enter a cocoon state and level up if you don't kill them quickly enough. New guns help mitigate these threats. Cryo weapons freeze enemies when their elemental effect triggers. Better yet are the new lasers: wrangling a line of energy in mid-air is like trying to spray someone with a firehose after leaping off a trampoline.

Broadly, that's the extent of what's new in *The Pre-Sequel*; there aren't many other new weapon types or attributes to fill out the armoury further. Likewise, I didn't find the new enemies to have nearly as much personality as *Borderlands 2's* half-clothed, charmingly crude bandits. Mechanically they're interesting enough: tracking jetpackers while you yourself are airborne is a fun challenge, and engineer enemies throw up bubble shields that force you to engage at close range. But so

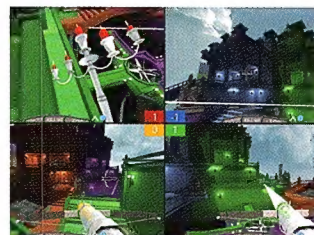
many of the baddies that you find yourself blasting after halfway point are straightforward space marines, who don't provide the same vulgar quips and last words that I loved hearing from *BL2's* scav. The late-game aliens are in the same boat, never uttering a word as you fight them. They aren't boring to fight, but their seriousness doesn't match the game's otherwise silly tone.

I do love the way that 2K Australia pokes some irreverent fun at its homeland, though. The best dialogue in the game comes from the inappropriately cheerful citizens of Elpis, who casually shrug off the moon's many dangers and drop exaggerated Australian slang.

The Pre-Sequel is happy to be just another *Borderlands* game. I enjoyed it, but I also finished it thinking my time would have been better spent on one of this year's more original games. ■ **Evan Lahti**

Verdict

A well-executed but unambitious extension of *Borderlands 2* that drops just short of a must-buy.



Screencheat

The only way you'll beat your friends at this is to peek.

US\$14.99 | PC
SAMURAI PUNK.COM

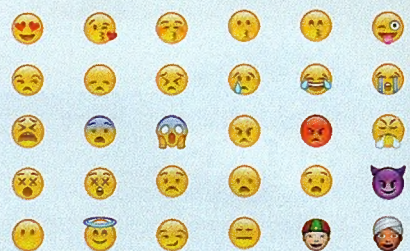
Screencheat is a competitive splitscreen shooter where four invisible players duke it out in tight, colour-coded arenas. You'll laugh, you'll cry, you'll cop a confetti spraying rainbow piñata in the face. Instead of monitoring your own quarter of the screen, you're encouraged to spend more time watching what your opponents are doing to figure out where they are. Those reared on N64-era splitscreen shooters will be familiar with this reprehensible tactic. *Screencheat* wields it as a central game mechanic. In standard deathmatch kills come thick and fast: the weapons emit faint evidence of their owner's location, and I quickly learned that precision and planning was more important than spamming the attack key, which most newcomers instinctively do. The weapons are invariably one-shot kills, so there's initially no incentive to explore *Screencheat's* weirder weapons (explosive bouncing bears, modified car engines). Melee weapons like the Hobby Horse (which is on fire for some reason) and the Candelabra are good in tight situations, though tend to leave visual cues in their wake. Easy going in tone but frantic in nature, it seizes on a single novel idea and builds an enjoyable shooter around it. ■ **Shaun Prescott**



Paging all Star Trek fans!

Beam me up, Scottie.

Literally. The upcoming 'Onyx' from OnBeep is a wearable communications gadget that draws more than a little of its inspiration from the famous sci-fi series' 'communicator' badges, as worn by Starfleet personnel from the Picard era onward. (That's approximately Stardate 41,000 onward for any hard-core/sad Trekkies [That's Trekkers — Ed] out there.) While we've seen any number of wearable tech concepts roll out in the past year or two — smartwatches, fitness doodads, even Google Glass — this is perhaps the first real-world product seeking to replicate (ahem) the one-click comms badge design pioneered in the show. The Onyx, which is currently available for pre-order at www.onbeep.com, has been designed as a communication tool for workers and teams, pairing with your smartphone via Bluetooth for data connectivity. The first-gen model looks more than a little chunky to our eyes — this thing seems practically as hefty as Flavor Flav's trademark clock! — but with refinement and a little thinning down, this might well be the start of a promising new form factor...



No skin tone modifier



Emoji goes PC

Emoji, the symbol set that allows users to insert cute little visual icons as textual characters in their written dispatches, is getting a PC update — in this case meaning politically correct, as opposed to personal computer — with new support for a racial diversity modifier that enables people to specify unique skin tones for their smiley (or frowney) faces. In a new Unicode 8.0 update slated to go live next year, the skin tone modifier will enable Emoji faces to display a diverse range of skin tones rather than the default yellow. The new, realism-focused diversity policy represents a change of direction for Emoji, which previously followed a guideline suggesting Emoji characters should appear "as neutral as possible" regarding race, ethnicity, and gender."

Modern chat is riddled with insecurities

The Electronic Frontier Foundation has conducted a sweeping assessment of messaging apps to determine which platforms offer the most robust security for users, but in a damning condemnation of the state of most web communication systems has found that only six out of 39 of the services tested successfully met all the EFF's criteria for safeguarding user privacy. "The revelations from Edward Snowden confirm that governments are spying on our digital lives, devouring all communications that aren't protected by encryption," said EFF Technology Projects Director Peter Eckersley. "Many new tools claim to protect you, but don't include critical features like end-to-end encryption or secure deletion." Of the 39 services assessed (www.eff.org/secure-messaging-scorecard), all the most popular mainstream comms apps like Facebook Chat, Apple's FaceTime, Google Hangouts, iMessage, Skype, Snapchat and WhatsApp flunked one or more areas of the EFF's 'Secure Messaging Scorecard'. Ouch. So what are the secure messaging apps we should be using? The EFF gives the thumbs up to ChatSecure + Orbot, CryptoCat, Signal/RedPhone, Silent Phone, Silent Text and TextSecure. ■



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